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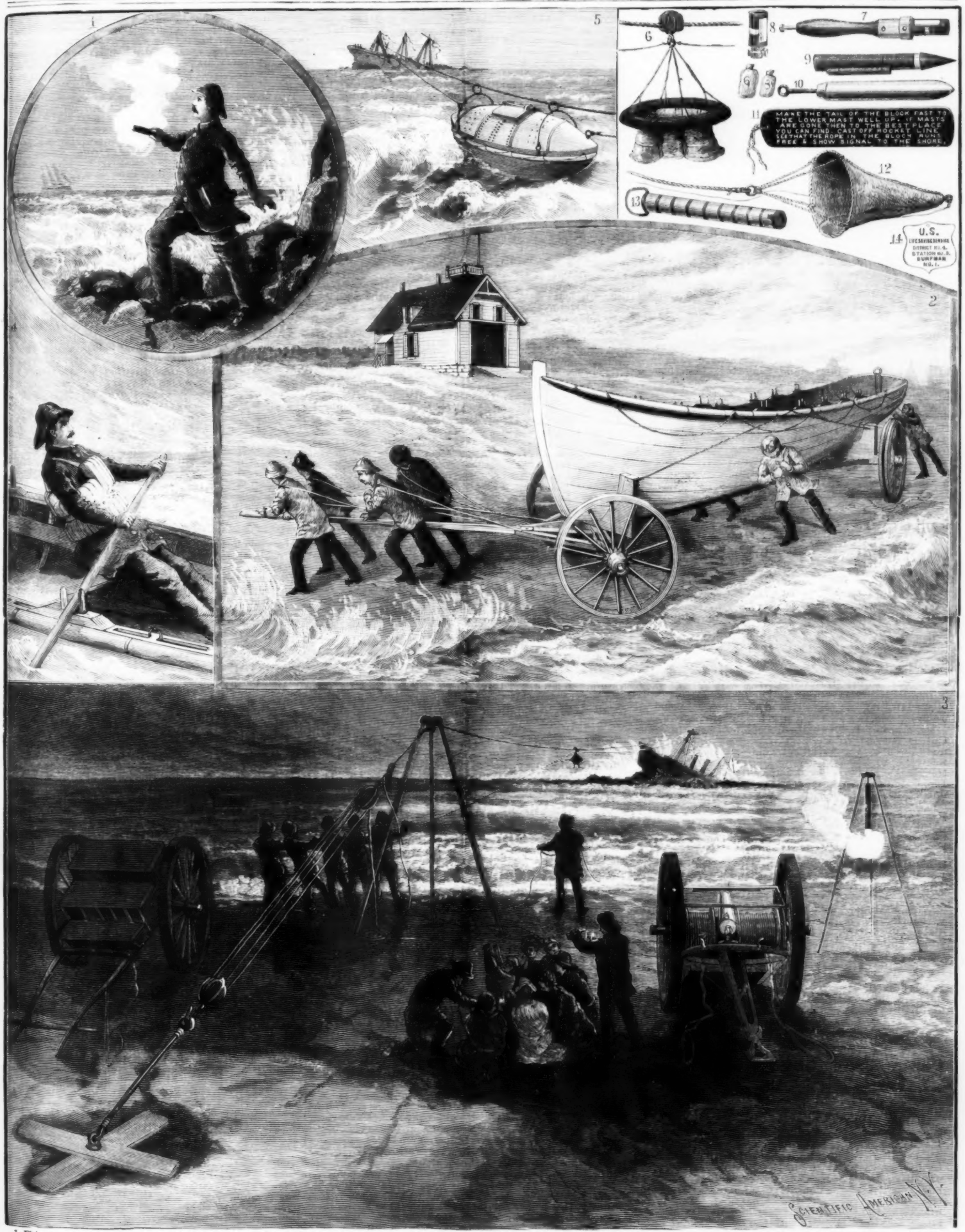
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## THE UNITED STATES LIFE SAVING SERVICE.

## THE UNITED STATES LIFE SAVING SERVICE.*

By HORACE L. PIPER, Assistant General Superintendent of the Service.

THE preservation of life from shipwreck was not among the objects which early enlisted the interest of men. Even as commerce extended its scope, the goods, not the sailors, were the objects of its solicitude. When the owner's right to his property was made to depend upon the fact that somebody should get ashore alive, it became a matter of care to the plunderers on the coast that nobody should reach the shore alive, or if anybody did, that he should straightway be put to death for his folly. To be sure, the coveted goods would not therefore lawfully belong to the wreckers, but "dead men tell no tales."

Although death in hideous form had long prior been denounced in England upon persons who, "more barbarous, cruel, and inhuman than mad dogs, murdered shipwrecked folk," the eighteenth century was well in its twilight before any organized effort, and that private, was made for the succor of such unhappy creatures. Our Declaration of Independence had been proclaimed and made good before such a thing as a life boat had been conceived in England, where the first one was invented; and George Washington had been two years in our presidential chair when the first serious steps were taken in "the mother country" for the rescue of the shipwrecked.

The good people of the United States were no laggards in this great work. The year 1786 witnessed the organization in Massachusetts of the Humane Society of that commonwealth, which three years later formally dedicated its energies to the rescue and relief of castaways on that coast. So, it happily appears that a life saving service of some sort, limited and imperfect it is true, began its career with the infant steps of the Republic. The Massachusetts society was the first organization of the kind in this country of which I have knowledge, and if it may not be called the parent of all others, it was at least the pioneer. Though already a centenarian, let us hope that it is still in the flower of youth.

The life saving service of the United States had its inception in the year 1848, when Congress first made an appropriation for such an agency of the general government. It may be worth while to note the fact that this was also the year in which attention was re-awakened to the same subject in England, where it had languished to such an extent that a recognized authority declares the whole system to have been "in such a low state that in the entire kingdom there were perhaps not a dozen really efficient life boats." But our appropriation of 1848 was only a beggarly pittance of $10,000, to be expended solely upon the coast of New Jersey. A few boat houses were cheaply erected and equipped with this sum, but although small appropriations were subsequently made for additional houses and equipments at other points, no crews were employed until 1869, and then only at alternate stations.

While it might not be true to say that the service from 1848 to 1871 was discreditable, it certainly was not brilliant. Its new and glorious career began on the 20th of April, 1871, when Congress made an appropriation of $200,000 for life saving purposes, to be expended by the Secretary of the Treasury through the medium of the Revenue Cutter Service, with which life saving operations were then connected. The chief of the Revenue Cutter Service, at that time, was a young man who had only a few weeks before taken charge of the office, and who had himself suggested the appropriation mentioned, and devised a scheme for its judicious expenditure. The marvelous results achieved with this comparatively small sum, the record showing that on the coast of Long Island and New Jersey, to which the appropriation was limited, every life imperiled by shipwreck during the following season was saved, induced further favorable action by Congress, gradually enlarging the service, and finally by the act of June 18, 1878, organizing it into a separate bureau.

Mr. Sumner I. Kimball, the chief of the Revenue Cutter Service to whom I have just referred, was nominated by the President, and, without the usual reference to a committee, unanimously confirmed by the Senate to be General Superintendent of the new Life Saving Service. This remarkable tribute of confidence was not accidental—it was earned. During his administration of the Revenue Cutter Service, Mr. Kimball had raised its status from one of waning importance and efficiency to a very creditable footing, and at the same time had elevated the Life Saving Service to such a plane that it began to command general interest and confidence. His assumption of the new office was marked with vigor and enterprise.

### DISTRICTS AND SUPERINTENDENTS.

Without undertaking to enumerate in full detail the various steps in organizing and perfecting the economy and morale of the service, let me proceed at once to submit, first, an outline of the organization as it now exists, and then as complete a *resumé* as possible within our limits of its operations.

The coasts of the Atlantic, Gulf of Mexico, Great Lakes and the Pacific—Alaska not included—comprising more than 10,000 miles, are divided into twelve life saving districts, designated by number, beginning with Maine on the Atlantic, and terminating with Washington on the Pacific. The first district includes the coast of Maine and New Hampshire; the second, Massachusetts; the third, Rhode Island and Long Island; the fourth, New Jersey; the fifth, Delaware, Maryland and Virginia to Cape Charles; the sixth, Virginia and North Carolina from Cape Henry to Cape Fear; the seventh, South Carolina, Georgia and Eastern Florida; the eighth, the Gulf of Mexico; the ninth, Lakes Ontario and Erie; the tenth, Lakes Huron and Superior; the eleventh, Lake Michigan; and the twelfth, the Pacific Coast.

Each district is in charge of a superintendent, chosen for his knowledge of the subject, business capacity, and executive ability. He must be a resident of his district, of good repute, not less than twenty-five nor more than fifty-five years old when appointed, is required to understand the use of life boats and life saving appliances, and to be familiar with the lines and dangers of the coast under his guardianship. He is the disbursing officer of the district, under a bond ranging from $10,000 to $50,000 in amount, must visit every station once in three months, oftener when necessary, examine and test the crews as to drill and discipline, and has general supervision of the property, surfmen and operations.

The single-hearted devotion of many of these men to their noble work is a matter of well deserved admiration. To them their vocation is much more than the mere holding of office with pecuniary reward. Nothing draws one so close to another as a kindred woe. Some of these men have themselves felt the clutch of the icy waters about them, and have been saved by only a little less than a miracle. In them the hoarse wail of the storm awakens the deepest emotions and the best impulses of human nature. Several have immortalized their names by acts of extraordinary heroism well worthy of recital here, but omitted for obvious reasons. Some have made important inventions and improvements in life saving appliances, and all are men of excellent reputation in their profession.

### STATIONS AND THEIR LOCATIONS.

The districts are subdivided into stations, known by the names of their localities, and situated with regard to the special dangers of the coast. They are of two kinds: complete life saving stations and houses of refuge. The former have a building constructed of wood without much reference to architectural effect, but designed to withstand the tempest and afford comfortable quarters for the surfmen and convenient rooms for the apparatus. On the first floor there are a boat room, kitchen, keeper's office, and sitting room for the crew; on the second floor, the sleeping apartments. A lookout tower for the day watch is placed upon the roof or near by, and there is a flag staff for signaling, the service co-operating in this matter with the maritime associations of the country. A wreck pole is also generally set up in the vicinity for the purpose of practice with the breeches buoy apparatus. The equipments usually comprise two boats with outfits, a life car, two sets of the breeches buoy, a Lyle life gun, cork jackets, heaving sticks, night signals, rockets, signal flags, barometer, thermometer, necessary furniture, etc. Crews, generally consisting of six men and a keeper, are maintained during the active season—defined hereafter—the keeper being required to reside at the station the year round, unless granted an occasional short leave of absence during the inactive season, when a substitute must be furnished.

A house of refuge is provided with a frame house of sufficient capacity to accommodate as many persons as are likely to be cast on the adjacent shore, and furnished with the means of supplying their immediate wants. A small boat is supplied for the use of the keeper, but no crew is maintained. The keeper and his family reside in the house, and the beach is patroled by them at such time as wrecks are likely to occur.

The whole number of stations of both kinds at the present time is 240, several of them not yet fully completed and manned.

By far the greater part of our ocean commerce is on the Atlantic, and on that dangerous coast are located a majority of the stations. On the coast of Maine and New Hampshire there are ten; these shores, though rugged and stormy, having excellent and numerous harbors of refuge. The Humane Society of Massachusetts renders good service from the New Hampshire line to Race Point on Cape Cod, and therefore the United States provide protection for only a half-dozen especially dangerous points within those limits.

In Mr. Kimball's address before the recent International Marine Conference, Cape Cod is aptly described as a narrow strip of sand, stretching directly out into the ocean some forty miles, then turning abruptly northward for an equal distance, like a threatening arm, its bars and beaches being the burial ground of unnumbered craft. Here ten stations keep "watch and ward," at nearly equal distances apart, and well arranged to co-operate with one another. From the extremity of the Cape to Montauk Point there are nine.

White-winged messengers of commerce swarm along the coasts of Long Island and New Jersey as a multitude throngs the principal thoroughfare of a metropolis, and these shores are abundant with perils. On Long Island there are thirty-nine and on the New Jersey coast forty stations. From Cape Henlopen to Cape Charles seventeen treacherous points are guarded; from Cape Henry to Cape Hatteras—the sailors' traditional horror—twenty-three. On the coast of Florida wrecks are usually cast well upon the land, the shipwrecked generally reaching the shore in safety, but sorely in need of temporary shelter and sustenance. Here are located the houses of refuge, ten in number, besides one fully equipped station at Jupiter Inlet, a point of considerable danger, about two-thirds the way down the coast. The Gulf of Mexico has points of sufficient importance to call for eight complete stations.

Passing up to the Great Lakes we find five immense bodies of water with few natural harbors, and freighted with commerce of amazing proportions. Here the mariner finds the dreaded lee shore always under his forefoot. The extraordinary dangers of these land-locked waters furnish ample work for forty-nine crews. On the Pacific coast strandings are not frequent, the prevailing winds blowing along rather than upon the shore. To the present time twelve stations have been located there.

### KEEPERS.

Every station is in charge of an officer who is really the captain of the crew, but is technically known as the keeper, that designation having been made in the early days when only one man was employed merely to keep the apparatus in order for the use of volunteers on occasions of wreck. The keeper is the person who directs the actual operations of life saving. He decides upon all the movements, commands and steers the boat, and exercises absolute authority over the crew. There are difficult and fearfully important questions to be decided, and the decision must be made then and there, under the pressure of excitement, with human life trembling in the balance. Obviously, this officer should be a man of skill in the surf, of sound discretion, of dauntless courage. He must be able-bodied, level-headed, and, like Nelson, unacquainted with fear.

As in the case of superintendents, the selection of keepers is a matter of great moment to the service. They are generally nominated by the district superintendents, with a written statement of reasons upon which the nominations are based. If approved by the general superintendent, appointment follows. Keepers must not be under twenty-one nor over forty-five years of age upon entering the service, and are required, aside from the requisite qualifications of surfmen, to possess sufficient education to keep the records of the station and conduct ordinary correspondence. Under this system an excellent body of men has been secured. Their record for courageous conduct in the face of extreme danger is without stain, but there have been some instances where a fatal error of judgment has required a keeper's removal. I recollect such a case (the error resulting in loss of life) where the keeper distinguished himself by the display of remarkable courage on the very occasion of his failure, risking his life with reckless daring, and even suffering physical injury. The general superintendent was criticised for this removal as an act of unnecessary harhness, but his conclusive reply was that when human life was at stake, whatever may be second among the qualifications of a keeper, unquestionable sound judgment must be first.

The keepers of complete stations are generally paid $700 per annum. The Secretary of the Treasury may, under the law, allow a maximum of $800, but this sum is awarded only in cases where keepers have won special merit by the exhibition of superior courage and capacity. Keepers of houses of refuge receive $600 each per annum.

### CREWS.

The crews are technically known as surfmen. Nobody need tell you what stuff they should be made of—the hazardous nature of their vocation tells that. Mere sailors will not do. Between the average sailor and a genuine surfman there is a wide difference; the former frequently, I might say generally, knowing little of surf life. These crews must be surfmen, they must be the best, with muscles of steel and hearts of oak. They are selected by the keeper from the best men obtainable in the neighborhood, and must not be over forty-five years of age when originally enlisted. They are admitted only after rigid examination as to their physical and professional qualifications. They may not be discharged without good cause, and (with only two exceptions) not without special authority from the general superintendent. The exceptions noted are neglect of patrol duty and disobedience at a wreck, for either of which a keeper may dismiss a man on the spot. Happily these offenses are of rare occurrence. Almost always the surfmen have displayed royal qualities crowned with dauntless courage. Their pay is $50 per month, during the active season only, and $3 for each occasion of service during the inactive season. From the meager sums paid to keepers and surfmen, they must supply their own food and clothing. That the rates of compensation are less than just is hardly an open question. At all events, as long as they prevail, the service may be considered safe from the assaults of unworthy seekers of soft places with fat salaries.

### DISCIPLINE.

Here is a large corps of men, numerously subdivided and widely scattered, whose efficiency depends upon discipline. How is that secured? In the first place the discipline of the crew devolves upon the keeper. He is required to keep a daily log or journal, in which must be noted all official transactions, including drill with the boat and practice with the beach apparatus. A transcript of the journal must be forwarded each week to the general superintendent at Washington, through the district superintendent. The keeper may generally be relied upon to report any serious infractions of the regulations, because, besides being required to do so, the maintenance of his own authority demands it.

But who is to maintain the watchful eye upon the keeper? Primarily he is under the charge of the district superintendent, who must make an inspection of all station affairs upon his quarterly visits, and render a report in writing to headquarters at Washington. There is also in each district an assistant inspector—an officer of the revenue cutter service, detailed for the duty—who is required to make a tour of the stations once every month during the active season; oftener if occasion should require. This officer drills the crew, examines them in their various duties, and is especially charged with matters looking to good order and discipline. He must also make a written report to headquarters at Washington. Then there is one general inspector of the service. Among a variety of other duties, he must make periodical inspection of all the districts, and file a report in detail at headquarters in Washington. Thus, it will be perceived, reports are constantly flowing from the branches to the center of the service.

With a view to entire equity as far as possible, the general superintendent has not discouraged those whom I may call the privates in the ranks from holding communication with himself, when they may feel that they should be heard directly without intervention. And yet all this would not make sure that condition of proper restraint and reasonable freedom essential to healthy *esprit de corps* if there were not at the head an ungloved hand upon the helm. The dignity and authority of the officers must be maintained, the rights and self-respect of the men preserved. No failure of duty is excused except upon strong reason, after searching investigation. The grievance of the humblest surfman is inquired into, and rectified if well grounded, with all the care and impartiality which attend the treatment of a complaint preferred by the highest officer. The result is that discipline is good, and there is coexistent with it that feeling of restfulness and contentment among the men which is indispensable to a healthful and successful service.

### OPERATIONS—BOATS.

On the Atlantic coast the "active season" opens on the 1st of September and closes on the 30th of April; on the lakes, it opens and closes with the opening and closing of navigation; on the Pacific the stations are open and manned the entire year, disasters occurring there more frequently from local causes than from mere stress of weather, and being about as likely to happen at one season as another.

On the Atlantic, the 1st of September witnesses the

* A lecture delivered before the Franklin Institute, Philadelphia, Pa. From the *Journal*.

muster of the crews. The men are told off by numbers, the presumably best surfman ranking as number one, next to the keeper, the others in regular numerical order according to known or supposed qualifications. The rules are read, and the house is set in order. Usually the members of the crew take turns in cooking, though they sometimes prefer to employ a cook. The domiciliary preparations having been completed, regular drill is begun, each day being set apart for a special purpose. The surf boat or the life boat is taken to the water, launched, and worked in the surf. Probably few who have ever gone out or come in through the breakers in a well handled boat have any adequate idea of the danger. This operation involves the most difficult boat management known to the sea, even on an ordinarily calm day. When the ocean is disturbed by the storm, the waves are lifted in huge volumes many feet into the air as if by some great magnet, which suddenly loses its power, and they fall with a deafening roar, chasing each other in fury across the beach often to the high land. The boat must never be caught on the crest of one of these foaming billows, but must lag behind, or run before them. These are tricks to be played with a treacherous foe, and woe to him who makes a mistake. In such case the boat is either broached to and capsized, or lifted on end and toppled over, when the hapless crew must swim for their lives.

Nothing steadies a boatman's nerve so much as confidence in his craft. He must feel that she is agile and seaworthy, and will not play him false. In pursuit of these qualities the service has expended indefatigable industry. On the more important parts of our coasts the English life boat would be useless. It is a grand boat, and there clusters about it a glory of successful effort which has made its very name honored and beloved, but its great weight restricts its use with us to exceptional localities. It weighs from two to four tons, is furnished with a heavy iron keel to secure the self-righting quality, and draws a good deal of water. Imagine seven or eight men on any of our flat beaches attempting to push one of these to deep water. Twenty men would exhaust their power and fail in the undertaking. Where these noble boats may be plunged at once into water of sufficient depth they are admirable, but for general purposes we have excellent models much less than half the weight of the lightest English life boat, and possessing its best qualities. The Beebe-McLellan surf boats are self-bailers, and as now equipped, readily righted if capsized. They are of light draft, easily launched and handled, and our crews have accomplished with them prodigies of surfmanship.

The Dobbins life boat, although heavier, is still comparatively light, and well adapted to the demands of many of our stations, where it has proved its efficiency. The same may be said of the Richardson life boat. All three of these boats have been invented or adapted by the skill and intelligence of officers of the service. There are also in use at appropriate places a number of boats of the English model.

Surprise is sometimes manifested by persons unacquainted with the use of life and surf boats that capsizes take place. It should be understood that no boat has yet been invented which may not be upset. If such were not the case, there would be no need of the self-righting quality, and a self-bailer furnished with air cases, so that she could not sink, would make life-boat service little more than a matter of exhilarating pastime. But while a capsize is liable to occur at any moment, our service has been reasonably free from serious casualties in this way. During the existence of the present system there have been some sixteen cases, including various types of boats, involving a loss of twenty-eight surfmen and fourteen shipwrecked people. During the same period, the English life boat, which is selected for comparison, because heretofore supposed to possess every attainable best quality, has capsized twenty-one times, with a loss of sixty-eight boatmen and seven shipwrecked persons. When the number of times our boats have been in service and the number of persons involved are considered, the percentage of loss is perhaps as small as may ever be expected—certainly so until some now inconceivable invention has rendered a capsize next to, if not absolutely, impossible.

### BREECHES BUOY—LYLE GUN—LIFE CAR.

Boat drill alternates with practice in working the breeches buoy apparatus. This device is like a pair of trunks or knee breeches made of canvas with a circular life buoy for a waist belt, and is hung by four small ropes to a pulley running on a hawser. First, a small line about a quarter of an inch in diameter and very strong is thrown over the ship with the gun. This line is hauled on board by the sailors, having attached to its shore end an endless larger line called the whip, run through a pulley, to which is attached a tally board with directions for its adjustment on board, printed in English and French. When the whip-line block reaches the vessel, it is made fast by the sailors, well up on the mast if possible.

The rest of the work is done by the life savers. Hauling on one part of the whip, they send out a three inch hawser, also bearing a tally board with instructions that it be made fast just above the whip line. The shore end of the hawser is anchored in the sand, and raised from the earth on a tripod or crotch. Then the breeches buoy is swung to the hawser, fastened to the whip, and all is ready. By pulling on one part of the whip the buoy is sent out, and by reversing the action drawn back, each return generally bringing to the shore in safety one or two people. By this simple contrivance thousands of lives have been saved. Practice with this apparatus is conducted on shore with the wreck pole, already referred to, serving as the mast of a disabled vessel. The life gun is the invention of Captain David A. Lyle, a distinguished officer of the ordnance corps of the United States army, whose name it bears. It is composed of bronze, and with its line-carrying projectile weighs a little over 200 pounds. It has a range, under the most favorable conditions, of nearly 700 yards, and has so far nobly met the requirements of the service.

The safety of the breeches buoy as a means of rescue is well established by the fact that there is but a single instance on our records where a person once embarked in it has been lost.

The life car now in use in our service embraces the essential features of the "Francis Metallic Life Car," made famous some forty years ago by the rescue of a large number of people from the wreck of the Ayrshire on the coast of New Jersey. The car of the life saving service is constructed of metal in the shape of a boat, sharp at both ends and housed in. Access is had by way of a small hatch, which may be securely fastened either on the outside or the inside, and the car may be drawn to and fro, either suspended on a hawser, or through the water. It is of sufficient capacity to accommodate several persons.

### LOOKOUT—PATROL—TELEPHONE.

From sunrise to sunset the lookouts by turns keep their perch in the lookout tower, and when night approaches the patrols prepare for the lonely tramp along the shore. At any hour from nightfall to daybreak, during the eight stormy months of the year, were you to find yourself on a beach protected by the life saving service, you would be sure of meeting one friendly traveler to give you greeting.

The importance of this system of patrol at night—and by day in thick weather—cannot be over-estimated. It makes sure that a wreck shall not come tumbling in, and be left undiscovered and helpless for hours when moments are precious, and delay is almost certain to result in unnecessary if not wholesale loss of life. By the patrol system a wreck is almost always discovered within an hour, generally in a few minutes.

The labor and hardship patrol duty imposes upon the surfmen are not likely to be fully appreciated until one is informed of the difficulties and dangers attending it. On some of our beaches the patrol is at all times compelled to wade for considerable portions of his beat through small streams and inlets, and when the tide is unusually high or the rivulets are swollen to formidable proportions, his duty is never without peril to his life. It not unfrequently happens that the way is lost, or the stress of circumstances compels a deviation from the usual course, when unseen and unknown dangers are encountered, such as bluffs and gullies, occasioning frequent injury by falling, etc.

The six members of the crew are divided into three reliefs of two men each, the first relief doing duty from sunset to eight o'clock—the men going in opposite directions; the second from eight to midnight, the third from midnight to 4 A. M., and the first again from 4 A. M. to sunrise, the order being so changed from day to day that the double duty of the first relief, as above indicated, shall not fall to the same individuals.

The patrolman is equipped with a lantern, a night signal or two, and a check. The lantern lights his way; the signal—something like a Roman candle burning a brilliant red light—is carried to warn off vessels standing in danger. During the last year 227 vessels were warned away and saved with many valuable lives by this simple beacon light. The check the patrolman carries to exchange with his fellow on the adjacent beat, each taking back as a voucher of his fidelity the one received from the other. Sometimes, alas! the check is never exchanged. Darkness and tempest and pitfall with exhausted human energy have conquered the brave heart, and its pulsations have expired on the stormy pathway of duty. It is a perilous task to traverse those desolate shores for miles in weather which would deter us from the streets of Philadelphia, and I can imagine no sadder scene than that which has been witnessed nore than once in our service, of a search party tenderly bearing back to the stricken station the body of a comrade fallen by the wayside, every man impressed with the knowledge that come what may, another must complete the broken journey.

Pertinent to lookout and patrol duty, and very closely related to it, may be mentioned the system of telephonic connection now widely used in the service. Where the coasts are most dangerous the stations are most numerous, and, therefore, nearest together, enabling them, if informed of a disaster, to co-operate in the work of rescue. The telephone furnishes a ready means of communication by day or night, and without the necessity of special operators to use it. The admirable results obtained in this way may be illustrated by the fact that as many as three crews have thus been brought together for combined service within less than two hours from the discovery of a doomed vessel.

While this feature is perhaps the most important, it by no means comprehends the entire benefits of the telephone. Nothing exerts a stronger influence upon individuals and communities than contact and association with others. Ambition and competition are thus aroused. Precisely this effect has been produced upon the morale of the service by the introduction of the telephone. A few men set apart in an isolated position, without outside associations, generally develop a tendency to sluggishness and demoralization, but when the telephone informs a crew that their neighbors are up and doing, out in a heavy surf, or at work on the beach, setting up the apparatus and landing a man in less than eight minutes—as is often done at drill—they are apt to conclude that they are just as capable as their enterprising comrades, and are generally not long in going to work to prove it. In this and similar obvious ways the telephone has proved an invaluable auxiliary to the efficiency of the service. To the present time, about one-half of the whole number of stations have been supplied with telephonic service. Extension is being made where feasible and desirable, as rapidly as circumstances admit.

### WRECKS.

When a wreck is discovered at night, a signal is burned to inform the disabled vessel that succor is at hand, and the patrolman hastens to the station to give the alarm. Then there is hurrying to and fro. Every man is on duty. The beach apparatus is at all times stowed in the hand cart in an orderly manner, having reference to the sequence of the use of the various parts. This apparatus consists of the gun for throwing the shot line, the whip line, hawser, sand anchor, breeches buoy, shovels, lanterns, and implements necessary to set up the gear. The surf or life boat, with its equipments, is always mounted on the wagon, and everything is ready, as in the engine house of a city fire department, to proceed without delay to the scene of operations.

Although the stations are located at points where wrecks are most likely to occur, the actual disaster is often several miles away. If possible, horses are used to draw the boat, while the men harness themselves to the hand cart, each man always taking the same relative position. The cart with its load weighs upward of 1,500 pounds, and the journey is often a toilsome one, the sea frequently running across the entire beach to the sand dunes, commonly called the sea wall, the men being then compelled to plod their way over a yielding surface, or seek a more solid road further to the rear. Sometimes the route leads through the forest, where a passage must be hewn with axes, so that the crew reaches the beach abreast the wreck in a condition well nigh exhaustion, while the battle with the sea is still to be fought.

Then comes the question of method—shall the boat be used or the life line? Meantime the roaring, tumbling, eager waters are doing their deadly work. Whatever is to be done must be done quickly. Here is a situation which makes a blunder almost as bad as a crime. If practicable, and especially if the stranded vessel is likely to break up at once, the boat is tried. This is required to be done because it is the readiest method, and if successful results in saving many lives at once; but to launch a boat in the face of an angry surf is frequently beyond the compass of the utmost skill and resolution. However, no keeper is excusable for failing to make an effort unless it would be obviously and beyond dispute foolhardy, or is clearly unnecessary. In such cases the breeches buoy or the life car is employed. The success of these methods depends upon the possibility of getting a line to the ship, which must be done with the gun, unless, as rarely happens, one is sent ashore by a float from the wreck.

Usually the gun is capable of reaching the vessel, and when communication is once established with the shot line, the first and great problem in the use of the breeches buoy or the car practically disappears. The lines and hawsers are of the finest quality, and seldom, almost never, break. These three methods, the boat, the breeches buoy and the life car, comprise all the means of life saving known and used in the world. When they have failed, hope may well give way to despair.

### RESULTS.

Omitting anything like an exhaustive statement, let me submit a few figures epitomizing the great results accomplished by the present system. During the destructive tempest of September, 1889, three crews in the vicinity of Cape Henlopen rescued 194 persons from twenty-two stranded vessels, thirty-nine being landed by boats, 135 by the breeches buoy, and twenty by the life car, not a soul being lost. On February 3, 1880, in a night of intense darkness wild with sleet and snow, the entire crew of four vessels were rescued upon the coast of New Jersey without the most trivial mishap. The appliances were set up and worked by the dim rays of ice-covered lanterns, under the most discouraging circumstances. It would be almost impossible to imagine better evidence than this of the usefulness of the daily drill to which I have already referred. During that year (1880), only nine persons were lost out of 1,980 imperiled. The smallest number lost in any other year was seventeen out of 3,950 imperiled. In the memorable March blizzard of that year (1888), fourteen sail vessels and two steamers were assisted near the Lewes, Del., breakwater, only two persons being lost. Four crews, thirty-two men, on the Delaware coast, served in the two years, 1888 and 1889, at sixty-five wrecks, rescuing 499 persons (an average of fifteen lives saved for each individual surfman).

Although the scope of a station's operations is usually limited to a few miles, much longer distances are sometimes made. Probably the most remarkable instance ever recorded occurred on the 18th of November, 1886. On the morning of that day, two ghostly figures, proving to be two vessels in distress, were discovered off the town of Marquette, on Lake Michigan. There was no life saving station there, and the people of the vicinity devoted the entire day to every sort of effort to reach the forlorn mariners. Boats and steam tugs were tried, a mortar and life line were invoked. All failed. With the departure of daylight a pall of horror and dismay enveloped the town. The nearest life saving station was at Ship Canal, on Lake Superior, 110 miles away. Faintly hoping, almost despairing, a telegram was sent stating the appalling facts. A special train was at once ordered at the nearest railway station to Ship Canal, and the crew and apparatus were hastily embarked in the midst of one of the heaviest snow storms of the year. Before midnight the life savers reached the scene of disaster, and after eight hours of indomitable effort safely landed the two entire crews, twenty-four persons. During that year, out of 6,601 lives imperiled, only fifty-eight were lost.

From 1850 to 1870, there were lost on the Long Island and New Jesey coasts alone, 512 lives—an average of twenty-five per annum; while under the present system from 1871 to 1889, with a largely augmented commerce and corresponding increase of disasters, there were lost 119, an average of less than seven per annum, a reduction of eighty per cent. It may be stated also that the figures for the former period (no official record having been kept) are undoubtedly far short of the true aggregate, while, for the latter period, all disasters are included. Taking the scope of the entire service into account, the loss of life under the present system has been only a small fraction over one in 100.

To summarize the whole matter in a single statement, the entire loss on all the coasts of the United States under the present system since 1871 has been only thirty-eight in excess of the loss on the Long Island and New Jersey coasts alone during the preceding twenty years. Twenty-eight of these were wreckers, who rashly cast off the lines of the life saving service already on board, and declined assistance until too late to be of any avail.

We have attended at 5,452 disasters, involving 46,383 lives, of which only 550 have been lost, including the twenty-eight unfortunate wreckers just mentioned, who were unquestionably the victims of their own folly. In addition to this grand total of lives preserved, we have saved and assisted to save property to the value of $89,337,179.

It is assumed that the status and achievements of the life saving service, even as imperfectly set forth in these remarks, must command general commendation, and I should be loth to close without naming the one factor which, perhaps more than any other in my opinion, has contributed to the splendid result. That is its non-partisanship.

In his annual report for 1880, the present general superintendent, urging the necessity of a statute to place the service on a non-political basis, recognized and sanctioned by the law of the land, made use of the following language:

"The last section of the proposed bill embodies the important provision that *the appointment and employment of all officers and crews of the life saving service shall be made solely with reference to their fitness and without reference to their political or party affiliations.*

"Much has been said in previous reports of the service, upon the necessity of selecting its agents strictly upon grounds of professional qualification, entirely ignoring all considerations of party or creed, and everything, in fact, but the plain business in hand. The sober sense of every thinking person will, it is believed, approve this line of conduct. The purpose for which the establishment is organized is simply to save lives from wrecks, and, secondarily, property; and to most effectively carry out this purpose the service must not be conducted in the interest of any platform or doctrine. The life saving service is eminently one of experts, and its agents must be the ablest trained professionals that can be secured.

"When the wrecked vessel is swept fore and aft by the winter seas, and haggard sailors and sobbing women and children are clinging to shroud and bulwark, the man who can best take out the life boat through the breakers to their rescue is the man of all men for this service, though he be a pagan. The gunner that can cast at the first fire the shot line over the breaking deck when the stormy night is blackest, and there is nothing to guide his aim but the spark of light made by the ship's lantern in the rigging amid the rending surf and overleaping spray, he will be proclaimed, by the sufferers his wreck-craft brings to shore, the man this service demands, though every caucus on the coast denounce his politics. If a patient be in mortal danger, and to save his life a capital operation is to be performed, we send for the surgeon. We raise no question of creed or party—we want only the surgeon, and we want the best. When the wreck is beating into ruin on the lee shore, the case is equally one of life and death, and equally, to the exclusion of every other consideration, is the highest professional ability required.

"Limiting the consideration simply to politics, it may be said that the required expert might be found in the ranks of the dominant party, and therefore chosen in the interests of that party. But the moment the principle of a political qualification is admitted, the selection, even from the party itself, is liable to be fatally influenced, because another object is introduced, namely, to reward some past political service, or to secure such service in the future; and the choice, as in the case of most political appointments, would then be made upon the recommendation of men of political prominence and aspirations in the locality of the position to be filled, in whom personal interest, the desire for party triumph, or the heat of party contest might bias the judgment or create the temptation to ignore or lower the professional standard, to palter with the facts of character and conduct, or to blink defect and incapacity, thus leading to the imposition upon the establishment of officers and surfmen in respect to their ability to control votes and carry elections, rather than to save human lives at shipwrecks. Such a rule, once put in operation, however good in intention, would end by supplanting superior agents with agents less good, or good for nothing.

"The effort to conduct the service without reference to such considerations has not been accomplished, it is needless to say, without serious difficulty. The success is only due to constant firmness on the part of the officers in its immediate charge, invariably supported, it is gratefully acknowledged, by superior official authority. But other men must succeed them, who perhaps, unwarned by an official experience, may have less resolution, or entertain different convictions, or who may simply serve the policy of future administrations possessed with views of the entire compatibility of such a service with party politics. The time for such a change in the fortunes of the life saving service may come, and in the stations trained surfmen may one by one give way to mere party hacks, perhaps even to the point of entire substitution. But if it does come—and this conviction it is desired to put on record—from that time the usefulness of the service will be on the wane. Its efficiency is coexistent with its continuance in the hands of the best surfmen, chosen only for their professional mastery of the methods it employs.

"The section of the bill referred to would erect the only solid barrier which can protect the service from the dreaded encroachment.

"When by statute there can be no question of the singleness of purpose of the service, the answer to those who would use it for other ends is made before they arrive. This provision of the bill is therefore earnestly recommended."

On the 4th of May, 1882, an Act of Congress embodying the provision urged in the above quotation was approved by the President of the United States. It is the law; it has been faithfully observed, and as long as it continues to be, the service must command public confidence and will succeed.

## HARFIELD'S COMPENSATING STEERING GEAR.

AT the recent naval exhibition in London, Messrs. Harfield & Co., Blayden-on-Tyne, exhibited their patent compensating steering gear, at the end of the Camperdown Gallery. A specimen of the new gear, and another of the ordinary screw gear, were placed together upon a platform, and as it was, of course, impossible to arrange a proper rudder to be moved in water, a similar effect was obtained by attaching a heavy weight to the end of a lever keyed upon a horizontal shaft, with which either of the steering gears could in turn be connected. The weight itself was one ton, and the distance from the center of the horizontal shaft to the center of gravity of the weight was 3 ft. 8 in. A pointer was attached to each of the gears above the platform, and as it moved with the gear the angle at which the rudder stood could be read off upon a divided sector; the weighted lever of course hung vertically downward when the pointer stood at zero, and as the helm was put over, the lever was raised through a corresponding angle.

The two specimens of steering gear were both provided with steering wheels of the same diameter, and with the ordinary screw gear 5¾ complete turns were necessary to put the rudder over from amidships to 40°, while with Harfield's gear, 5¼ turns were needed to effect the same result. The details of the new gear will be readily understood from our illustrations. Fig. 1 represents an elevation and plan of the gear, and this arrangement, with slight changes in detail, has been applied to H.M.S. Sirius, Spartan, etc. The steam engine drives a shaft upon which is fixed a worm which gears with the worm wheel, B, driving round the vertical shaft, at the upper end of which is keyed an eccentric pinion, which is well shown upon the plan. This pinion is similar to the wheels used in quick return motions upon some machine tools, and it acts upon a toothed quadrant of such a form as to gear perfectly with it in every position. It will thus be seen that when the rudder lies amidships, and is gradually moved sideways, the leverage of the engine gradually increases until when the rudder is full over the leverage is a maximum, the movement of the rudder being somewhat slower if the speed of the engine remains constant. The force acting upon the rudder is, therefore, proportional to the strain which comes upon it by the movement of the ship through the water. The bevel wheels shown above the eccentric pinion are connected to the hand gear, and can be thrown in and out by suitable clutch gear.

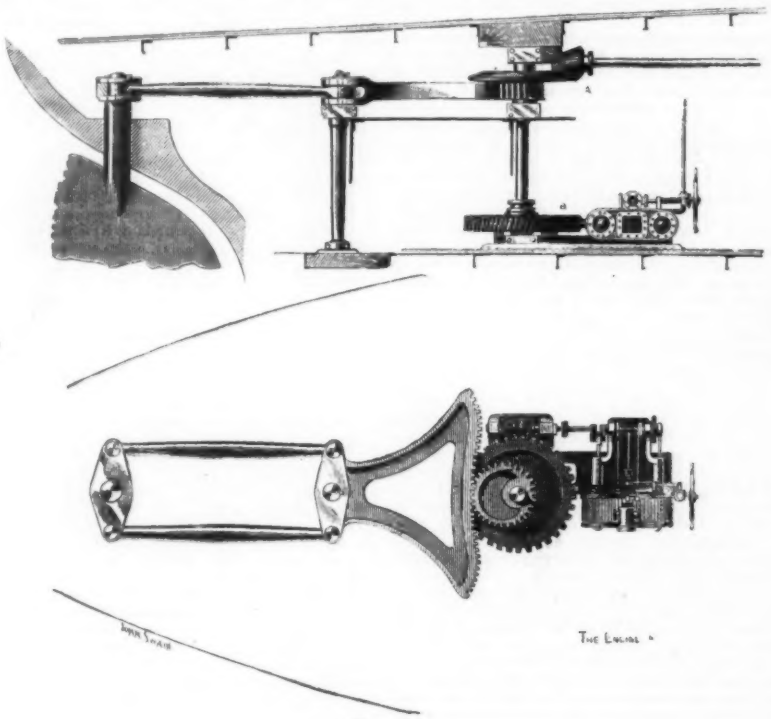


FIG. 1.

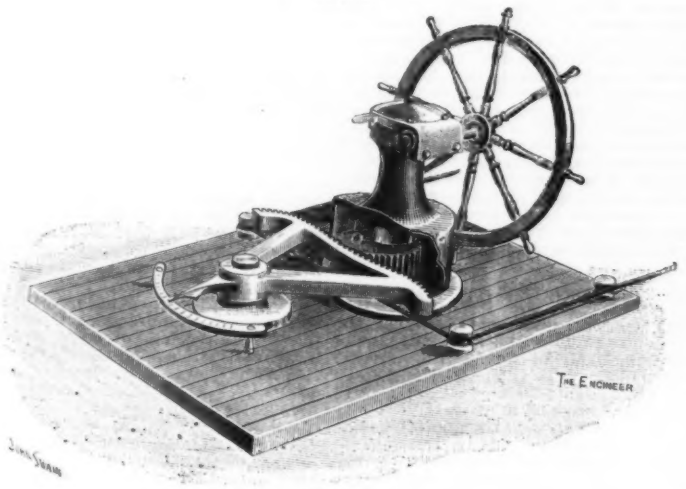


FIG. 2.

## IMPROVED COMPENSATING STEERING GEAR.

Fig. 2 represents the arrangement of the steering gear when used for hand power; the catch shown at the top of the pedestal controls a clutch, by means of which the hand wheels can be disconnected, and the work done by the wire ropes shown below. The illustration has been made from a model of the gear, which was provided with a pointer working over a dial as used in the experiments at the naval exhibition, and part of the pedestal is shown broken away to allow the eccentric pinion to be seen.

Comparative tests of the two gears were made at the naval exhibition, in the presence of Captain F. Le Clerc, the Naval Attache to the French Embassy, on behalf of the French government, when we were present. The steering gear was moved until the pointer recorded a given number of degrees, the steering wheel was then turned back until the pointer had moved half a degree; a rope was then fastened round the base of one of the spokes, and the pull at the circumference required to move the pointer back to the given number of degrees was read off upon a spring balance.

It was thought that in order to obtain an absolutely correct tangential pull upon the steering wheel, it was advisable to pass the rope round a pulley. Wooden sections of a grooved wheel were therefore fixed to the steering wheel, and the rope passed round, and the pull was put on by means of a small worm and wheel which caused the rope to be wrapped on a cylinder. A steady pull was thus obtained; and the tension on the rope was read off upon a Salter's spring balance, which was afterward tested with standard weights and found to be correct. The results obtained in the tests are given in the table below:

| Angle of rudder from center line of vessel. Deg. | Pull in pounds at circumference of grooved pulley. Harfield's gear. | Ordinary gear. |
|---|---|---|
| 5 | 11·3 | 25·0 |
| 10 | 24·0 | 52·0 |
| 15 | 39·6 | 84·3 |
| 20 | 55·6 | 118·6 |
| 25 | 57·3 | 150·0 |
| 30 | 51·6 | 175·5 |
| 35 | 45·6 | 263·3 |
| 40 | 38·6 | No test. |

In each case three tests were made for each position, and the values in the table are the averages of the results obtained in our presence at the naval exhibition.

Messrs. Harfield have kindly furnished us with the following particulars of strains:

| Angle of rudder from center line of vessel. Deg. | Strain on rudder head in foot-tons. | Strain at periphery of driving wheel, B, in tons. |
|---|---|---|
| 5 | 15·19 | 2·4 |
| 10 | 30·27 | 4·5 |
| 15 | 45·0 | 6·1 |
| 17·5 | 52·3 | 6·7 |
| 20·0 | 59·6 | 6·9 |
| 25·0 | 73·6 | 7·0 |
| 30·0 | 87·0 | 6·5 |
| 35·0 | 100·0 | 6·3 |

When the diameter of the pitch circle of the bevel wheel, A, is the same as that of the worm wheel, B, the strains upon it will, of course, be the same as those given for B.

It is also worthy of note that tests were made as to the speed and ease with which each gear could be worked, and it was found that with the ordinary gear it took two sailors of the Royal Navy 30 seconds to put the rudder over to 40°, and 10 seconds to bring it back

amidships; while with the Harfield compensating gear it took one sailor only 15 seconds to put it over to 40° and 4 seconds to bring it back amidships. The makers inform us that with their new gear fitted on board H.M.S. Sirius, two men could put the rudder "hard over" in 30 seconds in still water, whereas in a sister ship, under the same conditions, it took twelve men, and could only then be done very slowly.—*The Engineer.*

## THE NEW RAILWAY BRIDGE, SORIA, SPAIN.

OUR engraving illustrates the new railway bridge recently erected over the river Golmayo, on the Soria railway, near Madrid. The length of the bridge is about 200 ft., resting on five iron piers, of which the three central ones are each a little over 100 ft. in height, having masonry foundations. The ironwork was made in Belgium, and the bridge was erected by operatives from that country. For our engraving we are indebted to *La Ilustracion Española.*

## PULLMAN'S PALACE CAR CO. STANDARD SLEEPING CAR.

IN the latest design of sleeping car as built by the Pullman company, the car measures nearly 70 feet over the end sills, or 76 feet over the vestibules, and 9 feet 8 inches over the side sills. It contains, in addition to the 12 sections of ordinary lower and upper berths, a drawing room with annex toilet, a combined smoking and gentleman's toilet room, a ladies' toilet room, a heater room and a number of lockers. The car weighs nearly 50 tons and costs, inclusive of furnishings, about $18,000.

Owing to the extreme length, the center and intermediate timbers or sills are usually spliced; these are 4 inches by 6½ inches in size, while the side sills are 5 inches, by 8 inches, the floor being flush with their upper edge. The floor, which consists of two thicknesses of ⅞ inch matched boards, is applied diagonally and in such a manner that the joints in one course cross those of the other at right angles. As the intermediate sills are placed nearly three feet from the side sills to make room for the 42 inch wheels with which these cars are equipped, an additional support for the floor is provided in the nailing strip, which is framed to the lateral distance pieces. The end sill is also rabbeted to receive the floors, but is otherwise framed and fastened in the usual manner.

There are four trussed needle beams, two of which simply acting as ties; they are also attached as customary.

The body bolster is of the double variety, and is constructed with 6 inch tension and compression bars; it is located 5 feet 4⅛ inches and 10 feet 7⅛ inches, respectively, measuring from the end of the frame.

The two body truss rods are located immediately under the side sills, the ends being attached by means of pins to suitable irons securely bolted to the under side of the sills near the second bolster.

The bracing in the side walls of this car is very strong and may be said to be a combination of the leading methods, both the A brace, together with the inverted truss rod for holding up the corners, and the short diagonal braces with hook rods being employed; in addition to this it was found necessary, since the vestibule has been added, to block the spaces formed by the uprights and nailing strips, for a distance of about 13 feet, measuring from the end sill back.

The members of the A brace are 1½ inches by 6 inches and 1½ inches by 7 inches, let in flush with the posts; the short diagonal braces 1½ inches by 4¼ inches, and their accompanying rods ⅝ inch, and the long inverted truss rods ⅝ inch by 2 inches; the latter are supported on cast iron struts located between the bolsters. The remainder of the side frame is constructed with a 2 inch by 5½ inch plate, 1¼ inches by 4 inches and 2½ inch by 4 inch posts, ⅝ inch tie rods, a 2¼ inch by 11½ inch truss plank, a 2 inch by 4 inch belt rail, 1½ inch by 3 inch nailing strips and ⅞ inch and 1¼ inch furring blocks. The letter board, which has an effective cross section equal to 1¾ inches by 15 inches, also adds some to the strength of the side frame.

The exterior is covered with ⅝ inch narrow matched and beaded strips which are carefully attached both with glue and nails.

The roof is framed with 2 inch by 5½ inch deck sills, 2 inch by 4½ inch deck plates and 1¼ inch rafters, which are spaced about 12 inches apart; at the points where partitions are located, there are 2 inch cross carlines and at every section a ½ inch by 2 inch iron carline. The roof sheathing is ⅝ inch matched stuff; the covering is tin.

The exterior is painted with the dark shade known among car builders as the Pullman color, and is elaborately ornamented in gold leaf. The windows are made to appear large by finishing the woodwork, which separates each pair, in natural wood color same as the sash and by making one transom light for each pair of windows; this transom light is embossed and partially backed with silver leaf so as to hide the construction back of it.

The interior of the Pullman car is noted for its elaborate and artistic treatment. In the main room the woodwork, which is of mahogany, is less prominent than formerly, most of the panels being of embossed silk plush of a harmonizing shade; referring to the bunk section and the partition at either end of the room, in the former about one-half of the bunk front, nearly all of the belt below the deck windows, the panels between them, and in the latter the arch and small panels at each side of this, are so treated.

There is a small bevel edged mirror between the windows in each section and a large one on each side of the opening in the partition. The space above the partition, and between this and the ceiling, is partially stopped by bevel edged plate glass mounted in brass frames, and partially by an open bronze grill.

The ceiling is of three ply veneer, painted a light shade and ornamented partially in relief.

The high backed seats are covered with embossed plush of the same shade as that in the panels. The lamps and other trimmings are of bronze of a quiet pattern. The curtain rods, which were formerly so prominent, are now so arranged that they can be concealed when not in use. The floor is covered with a rich carpet of a special pattern, and harmonizes with the finish and the other furnishings of the room.

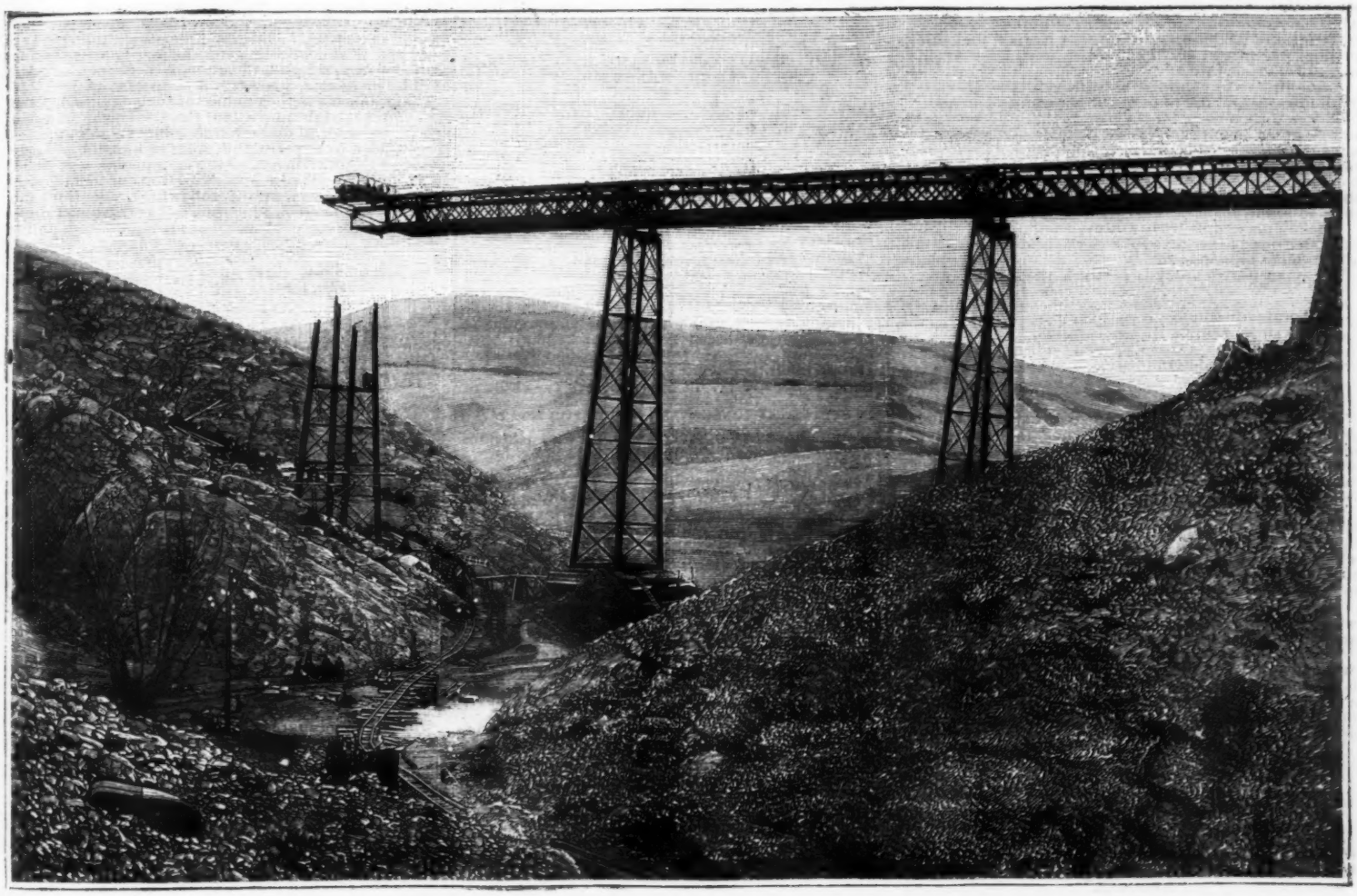
The drawing room differs from the main room in the details of the partitions only. As there are no bunks in the smoking room, the style of the finish in this is somewhat different; the woodwork is of English oak, which is relieved by panels of stamped leather and bevel edged mirrors, which latter, as this room is also used as a toilet room, are rather numerous.

The passages, saloons, etc., are not nearly as elaborately finished as the rooms above mentioned; still they are in keeping with the general design. The wash stands and bowls are of silver plated sheet brass, and are supplied with both hot and cold water, which is carried in tanks suspended from the bottom of the car body. By admitting compressed air, which is obtained from the locomotive through the air brake pipe, above the water, this is forced through the pipes to where it is required.

The car is warmed by a Baker heater, which, as the car is so large, has two circulating coils. Cars running over roads where steam heating is employed are arranged so that the water in the heating pipes can be circulated by steam.

Ventilation is provided for by opening the deck windows, which are hung with ratchet pivots in the ordinary manner; the supply of air, formerly admitted through the screens under the platform hood, is cut off by the vestibules.

Ordinarily, the cars are lighted by Hicks & Smith mineral sperm oil burning lamps, which are set in chandeliers attached to the ceiling of the car; the total number of lights is 26. In quite a number of instances the Pintsch light is employed, and in some cases incandescent electric lights.—*National Car Builder.*



THE NEW RAILWAY BRIDGE OVER THE RIVER GOLMAYO, SORIA, SPAIN.

## CAR HEATING BY THE ACETATE OF SODA METHOD.

IN a recent issue of *Les Annales des Travaux Publics* a number of illustrations showing the acetate of soda car heating method adopted on the trains of the Holland railroads, in accordance with the plans of M. Scholte, engineer of the car heating department, are given. The broad principle underlying the soda method, as is generally known, is that, in fusing, the acetate of soda takes up a certain quantity of heat which, in great part, is again liberated when the soda recrystallizes on cooling. Fusion of the soda takes place at a temperature of about 130° C., and during the next 2½ hours it cools gradually from 120° to 50°, recrystallizing and giving up its latent heat. The final temperature of 50° C. is maintained for an additional period of about three hours, so that, altogether, the entire period of heating covers about six hours. In the soda process, as used on the French railroads, the receptacle containing the salt is hermetically sealed, and the recrystallizing process, on cooling, thus goes on within a confined space. M. Scholte, however, has recognized the importance of air in crystallization, and, therefore, after having fused the soda, for an instant opens an air cock on the soda receptacle. This lets in enough air, he thinks, to assist in proper crystallization. In the process, as practiced in France, moreover, the fusion of the salt is effected by plunging the soda receptacle, which consists of sheet

iron, into a bath of boiling water and leaving it there from about three-quarters of an hour to an hour. M. Scholte, on the other hand, fuses the soda by means of steam under pressure, which is introduced through a copper pipe coil in the soda receptacle. This, it is claimed, permits an even distribution of the necessary heat for fusion, as against the simple surface heating attainable by the French method. M. Scholte has also perfected his arrangements so that it is not necessary to remove the soda boxes from the cars when they are to be heated. They can be left in their places and heated by coupling on a steam pipe from the outside.

## "PRESERVALINE," A NEW PRESERVATIVE FOR MEAT.

By Dr. BRUNO TERNE.

SOME time ago, I was applied to for information as to how to pickle meat without the use of nitrate of potash or saltpeter. The objections to the use of saltpeter are said to be:

1. The operation of curing takes too long a time.
2. It renders the outside of the meat hard.

"There is a compound," my inquirer said, "that is used in large quantities in the West, and which avoids both these objections. What is it?"

I informed him that if he would procure me a sample of this material, or would, in lieu of this, furnish me either with a specimen of meat prepared with it, or with some of the pickle as prepared for use, I might be able to throw some light upon the subject.

Shortly after this, I came into possession of two samples, both in pulverulent form, one red and the other white in color. I exhibit specimens of both of these preparations. From another source I learned that this product was placed on the market under the trade name of "Preservaline."

A qualitative test showed conclusively the absence of all nitrates and the presence of boracic acid in combination with a base, for the reason that the characteristic green coloration of the flame only appeared after the addition of a drop of sulphuric acid. It appeared further that both the red and white samples had the same composition, with the sole difference that to the colored sample there had evidently been added some rosanilin color.

I made up a sample with a little rosolic acid which exhibited nearly the same color as the original one, but a little more pronounced.

The quantitative analysis of the white sample gave:

| | Per Cent. |
|---|---|
| Biborate of sodium | 44·18 |
| Chloride of sodium | 45·30 |
| Moisture | 7·80 |
| Impurities undetermined) | 2·82 |
| | 100·00 |

Practically, then, we have here a mixture of equal parts of borax and common salt, and the "regular" preservaline, which imparts to the meat a cherry red color, as per announcement of the manufacturers and venders of this article, is simply the same product, with the addition of some coloring matter or dye.

I was aware that the use of coloring matters was largely employed in certain articles of food, especially in all candies and cakes, and the like, but it was somewhat of a surprise to learn that enterprise in this direction had progressed so far as to impose dyed meat upon us.

I investigated the red sample for traces of arsenic, which possibly might be contained in the color, but I am glad to report that I found none.

The solution of both samples was strongly alkaline. Without any doubt this product, on account of the large quantity of borax in its composition, will act as a good preservative, but it is unquestionably a fraud upon the public, so far as the selling price is concerned, as the following statement will show:

| | Cents. |
|---|---|
| One lb. of borax is worth | 9 |
| One lb. of salt " " | 1½ |
| Two lb. of mixed salt is worth | 10½ |
| One lb. of " " " | 5¼ |

It is put upon the market for the prices indicated in the following tabulation, reproduced from the manufacturer's circular:

"REGULAR."

| For Curing Pork and Beef. | Per Pound. Cents. |
|---|---|
| In barrels | 14 |
| 100 lb. kegs | 15 |
| 50 lb. drums | 16 |
| 25 lb. drums | 16 |
| 10 lb. boxes | 16 |

Use one pound for every 100 pounds of meat.

This preservaline gives the meat a cherry red color.

"A."

| For Pork and Liver Sausage. | Per Pound. Cents. |
|---|---|
| In barrels | 24 |
| 100 lb. kegs | 25 |
| 50 lb. drums | 26 |
| 25 lb. drums | 26 |
| 10 lb. boxes | 26 |

Sprinkle one-half pound over every 100 pounds of meat while being chopped or mixed.

"B."

| For Bologna and Smoked Sausage. | Per Pound. Cents. |
|---|---|
| In barrels | 16 |
| 100 lb. kegs | 17 |
| 50 lb. drums | 18 |
| 25 lb. drums | 18 |
| 10 lb. boxes | 18 |

Use one pound for every 100 pounds of meat.

Preservaline prevents any kind of sausage from turning sour, even in the warmest weather, and retains the natural color of the sausage.

Looking over the literature of the subject, I found that a series of investigations of similar products had been made by Mr. G. Polenski (*vide Reports of the Imperial German Health Office*, 1889, No. 5, p. 364). I quote therefrom the following data, respecting the composition of a number of such materials.

(1) THE REAL AUSTRALIAN MEAT PRESERVER.

(A nearly colorless liquid, emitting a strong odor of sulphurous acid.) It contains in one liter:

| | Grammes. |
|---|---|
| Calcium oxide | 11·08 |
| Sulphurous acid | 46·03 |
| Ferric oxide (alumina) | 0·039 |
| Silicic acid | 0·052 |

(2) REAL AMERICAN MEAT PRESERVER.

(The same liquid, but a stronger solution.) Contains per liter:

| | Grammes. |
|---|---|
| Calcium oxide | 26·42 |
| Sulphurous acid | 89·60 |
| Ferric oxide (alumina) | 1·80 |
| Silicic acid and alkalies | 1·20 |

(3) CONSERVATIVE FOR SAUSAGES.

(The same liquid, slightly opaque, but odorless.) Contains per liter:

| | Grammes. |
|---|---|
| Saltpeter | 33·40 |
| Boracic acid | 27·50 |
| Glycerine | 50·00 |

(4) PRESERVING SALT OF R. LEISENTHAL, COLOGNE.

(Does not redden the meat.)

| | |
|---|---|
| Borax | 48·40 |
| Water of crystallization | 39·00 |
| Common salt | 3·44 |
| Sodium bicarbonate | 9·10 |

(5) PRESERVING SALT OF THE SAME MANUFACTURER (TO MAKE THE MEAT RED).

| | Per Cent. |
|---|---|
| Boracic acid | 28·34 |
| Common salt | 9·58 |
| Saltpeter | 57·35 |
| Water | 4·50 |

(6) PRESERVING SALT OF GAASE BROS., BERLIN.

| | Per Cent. |
|---|---|
| Boracic acid | 29·70 |
| Saltpeter | 37·80 |
| Common salt | 26·70 |
| Water | 5·80 |

(7) AMERICAN HAM PRESERVER.

(An acid, yellowish liquid, having an empyreumatic odor.) Contains per liter:

| | Grammes. |
|---|---|
| Potash alum | 70·00 |
| Saltpeter | 21·04 |

(8) STUTTGART CONSERVING LIQUID FOR MEAT.

(An acid liquid, having a strong sulphurous acid odor and a yellowish color.) Contains per liter:

| | Grammes. |
|---|---|
| Arsenious acid ($As_2O_3$) | 0·103 |
| Common salt | 5·500 |
| Phosphate of lime ($Ca_3(PO_4)_2$) | 41·940 |
| Sesquioxide of iron and alumina | 0·440 |
| Sulphurous acid | 37·440 |
| Free phosphoric acid ($H_3PO_4$) | 6·050 |

(9) SIMPLE CONSERVING SALT, OF CONSERVING SALT CO., HAGEN.

(A white salt, in solution, alkaline.) Contains:

| | Per Cent. |
|---|---|
| Borax | 21·95 |
| Water of crystallization | 13·30 |
| Saltpeter | 33·10 |
| Common salt | 32·04 |

(10) TRIPLE CONSERVING SALT OF THE SAME MANUFACTURER.

| | Per Cent. |
|---|---|
| Salt | 0·80 |
| Boracic acid | 55·50 |
| Borax | 29·00 |
| Water of crystallization | 14·70 |

(11) SAZOLITH.

| | Per Cent. |
|---|---|
| Sulphate of soda | 37·3 |
| Sulphurous acid | 39·7 |
| Soda | 21·0 |
| Water | 2·0 |

(12) BERLINIT.

| | Per Cent. |
|---|---|
| Common salt | 7·5 |
| Boracic acid | 9·0 |
| Borax | 82·7 |

BERLINIT PICKLE (for reddening the meat).

| | Per Cent. |
|---|---|
| Salt | 45·9 |
| Saltpeter | 32·2 |
| Boracic acid | 19·2 |
| Water | 2·0 |

(13) CHINA PRESERVING POWDER. (MINERVA.)

| | Per Cent. |
|---|---|
| Common salt | 25·00 |
| Boracic acid | 17·7 |
| Sulphate of sodium | 38·8 |
| Sulphite of sodium | 9·2 |
| Water | 9·3 |

(14) AUSTRALIAN SALT.

| | Per Cent. |
|---|---|
| Common salt | 5·5 |
| Borax | 94·0 |
| Hydrocarbon (?) | 0·5 |

(15) DR. C. RUEGER'S BARMENIT.

Equal parts of borax and common salt.

This last brings us home again. American ingenuity, it will be perceived, is again in the lead. All the liquids and powders here referred to are free from coloring matter. They all use saltpeter to impart the red color to the meat, but the inventor of preservaline introduces the novelty of a dye to take its place.

The directions given by the manufacturer for the use of the red "regular" for curing pork and beef prescribe one pound for every 100 pounds of meat. This is equal to one-half per cent. of borax.

The prescription for the white, for curing bologna and smoked sausages, indicates the same quantity.

We have no positive knowlege of the action of large quantities of borax upon the human organism, when taken internally, though there can hardly be any doubt that, if taken even in small doses continuously for a considerable time, its effect must be hurtful. This question, however, I leave to the decision of others better qualified for passing judgment upon it than myself. It was simply my intention to call to your notice the common use of borax as a preservative for meat, and especially the misuse of anilin red to replace in such mixtures the use of saltpeter.—*Jour. Franklin Institute.*

## PRESERVATION OF WOOD.

ACCORDING to the *Comptes Rendus Mensuel di la Societe de l'Industrie Minerale*, some experiments have been made at St. Elroy, in Auvergne, France, on the actual effect of preservatives on the durability of wood of different kinds.

Seven woods were selected: Oak thirty-five years old, oak twenty-seven years old, fir, pine, birch, beech, poplar. The tests were made on fifty-two disks, each ¼ in. thick. Two disks of each wood were kept dry above ground, and the remainder were suspended in a cage in a damp mine having a temperature of about 75 deg. Fah. Two specimens of each wood were untreated in any way, while the others were protected by some one of the following substances: Solution of sulphate of iron, solution of sulphate of copper, solution of chloride of zinc, creosote, oil paint or tar.

The specimens were examined at various periods, from six months to eight and a half years. The unprotected specimens were all destroyed in from two and a half to three and a half years, the order of durability being about as follows: Beech, oak No. 1, poplar, oak No. 2, birch, fir, pine. The preservative effects of the different substances is given in the following table from the *Engineering Record*, which shows the increased durability, the unprotected specimens being taken as unity:

| | Oak. No. 1. | Oak. No. 2. | Fir. | Pine. | Birch. | Beech. | Poplar. |
|---|---|---|---|---|---|---|---|
| Tar | 28·7 | 24·6 | 263·5 | 87·5 | 105·4 | 36·2 | 150·4 |
| Chloride of zinc | 10·5 | 9·2 | 50·0 | 26·3 | 18·6 | 52·5 | 34·7 |
| Oil paint | 6·1 | 10·2 | 31·7 | 54·5 | 25·0 | 12·1 | 2·5 |
| Sulphate of copper | 42·1 | 26·4 | 12·0 | 8·0 | 1·8 | 2·5 | 15·5 |
| Sulphate of iron | 18·0 | 13·5 | 12·1 | 4·2 | 4·7 | 3·5 | 2·9 |
| Creosote | 1·7 | 0·9 | 2·5 | 4·4 | 0·6 | 3·3 | 1·3 |

These results differ considerably from those of experiments made elsewhere, creosote being generally regarded as one of the best preservatives.

## MANUFACTURE OF ARTIFICIAL RUBBER AND LEATHER.

By A. J. LINGER.

THE chief product, which is the basis of all the other preparations, is the substance obtained by oxidizing and vulcanizing those oils which are easily applied to linen cloths, etc.

The product is afterward mixed with ground Trinity asphalt in the proportion of about three parts to one of oil; to this mixture a sufficient quantity of carbon bisulphide is added.

The different ingredients ought to be warmed, agitated, and freed from all dirt and sediment, mixed with the various gums and resinous materials employed, then spread over the cloth, etc., or the fabric run through a bath of the substance, it is immaterial which; that which is most suitable to the use for which the article is ultimately destined being preferable.

In making a substitute for caoutchouc, the composition ought to be mixed with inferior caoutchouc (Mozambique) and sulphur in equal parts or thereabout, and one-half part of chalk.

The result of this combination produces an ebonite eminently suited for employing as an electrical insulator and similar uses. If the product is mixed with one-half part of litharge, the ebonite obtained possesses the property of resisting the action of acids and other corrosive substances.

The same composition may be used for water-proofing and imitating leather, in which two cases the manner in which the mixture is made, and the proportions of the substances incorporated, naturally vary somewhat, the subsequent vulcanizing of the product being accomplished by raising the temperature from 126° to 136°, and by the duration of the treatment, which varies from four to eight hours.

When it is desired to produce imitation leather, the inventor adds to the original combination the vulcanizing ingredients with one-fourth part of sulphur.—*Les Corp. Gras. Ind.*

## BLEACHING OF COTTON BY MEANS OF OXYGENATED WATER.

By M. PRUD'HOMME.

THE addition of calcined magnesia to oxygenated water when employed for bleaching cotton has been recognized as very advantageous. Its action is due to the formation of a peroxide of the formula $3\,Mg(OH)_2 + MgO(OH)_2$, which loses all its active oxygen at 300° C., but which is more staple than peroxide of hydrogen at 100° C. This peroxide has an alkaline reaction, and is formed when metallic magnesium is dissolved in oxygenated water. The oxides of zinc and cadmium behave similarly, the peroxide of the former having the composition $2\,ZnO+ZnO(OH)_2$.

In the bleaching of cotton oxygenated water does not act simply as a decolorizing agent, but attacks both the fatty bodies present and the cellulose, directly. The saponification of oils and fats is effected in

part by the magnesia, but the oxygenated water has also a direct action. On boiling a considerable amount of carbon dioxide is evolved, due to the oxidation of glycerol, while the neutral fatty bodies are also acted upon by acidulated oxygenated water with the formation of fatty acids and the evolution of carbon dioxide. The fatty acids themselves are still further oxidized both by the magnesia and by the oxygenated water, and the oleic acid formed is also partially converted into palmitic acid. The fatty bodies remain in the fiber as oleates and palmitates, etc., of magnesia, and are eliminated by treatment with dilute acid and alkali successively. Cellulose is transformed into oxycellulose by oxygenated water, an action which is much aided by the presence of metallic oxides, and also by mercerizing the cellulose beforehand, that is, by adding caustic soda to the bath used. A piece of cloth mordanted with iron, chromium, and alumina was considerably attacked by the oxygenated water in the parts covered by the mordants in 1-2 hours; it is therefore advisable to place the cloth, previously to bleaching it, in a bath of dilute acid, so as to remove any metallic salts or oxides that may be present. An ammoniacal copper solution acts upon cellulose very similarly to oxygenated water, and when employed in dilute solution, so as not to disintegrate the fiber, is found to act as a bleaching agent and to give rise to the formation of oxycellulose. Schweitzer's reagent therefore does really attack cellulose, a fact which is contrary to the generally accepted view of its action.—*Compt. Rend.*, 1891.

## FAST BLACK—A PREPARATION OF LOGWOOD.

By H. GUTKNECHT.

FOR some time past, a product obtained by the oxidation of logwood with potassium bichromate has been largely employed in the black dyeing of cotton goods. The following is a recipe for its preparation: To a mixture of 100 kilos. of logwood extract at 25° B. and 25 kilos. crude glycerin there is gradually added with constant stirring an oxidizing solution composed of 8 kilos. of potassium bichromate, 15 kilos. of chrome alum, 50 liters of water, and 12·6 kilos of hydrochloric acid at 20° B. The logwood-glycerin mixture, while undergoing oxidation, is heated to 100°, and this temperature maintained for ¼-½ hour after completing the addition of oxidizing solution. After cooling and allowing to stand for twelve hours, the product, which should be free from any sediment, is ready for use.

For use in cotton dyeing, 3-6 per cent. (of the weight of the cotton) of the above preparation is dissolved in water at 20°, the material to be dyed introduced, and the temperature of the bath raised to 40° in the course of 25-30 minutes.

To render it suitable for printing, the preparation is treated with 12 per cent. of its weight of sodium bisulpite at 40° B., and allowed to stand for about eight days. It yields a good black when printed on calico and steamed.

A cheap black ink may be prepared by diluting the oxidized logwood preparation (1 part) with water (10-15 parts), thickening with glucose, and neutralizing with sodium carbonate (about ½ per cent).

Glucose may be used instead of glycerin in the above recipe.—*Chem. Zeit.*

## ACTION OF LIGHT ON COLORS.

By T. FRYSHER.

THE author has exposed to light for a period of 40 days samples of a number of dyed colors, with the following results: Of the natural coloring matters, camwood, the fastest of the red woods, and fustic, the fastest of the yellow woods, both fade a little; logwood, in pale shades, is considerably decolorized, the destruction of color not being so apparent in dark shades; logwood blacks "finished" with chrome turn greener than unfinished blacks; vat-dyed indigo gives the fastest of all blue colors. Among the artificial coloring matters tested, alizarin blue and anthracene brown, in pale shades, are only moderately fast; gallocyanin is not quite so fast as alizarin blue; naphthol black, diamond black, anthracite black, and other wool-substantive azo blacks are much faster to light than logwood black.

## PYROTECHNY.

By T. A. ELLWOOD, A.I.C., F.C.S.

PYROTECHNY treats of the production of fires by combustion. It was discovered by the Chinese, with whom it remained a secret for centuries. Not until the thirteenth century did Europeans discover the property which certain substances possess of imparting color to flame. The manufacture of fireworks has now become a scientific art. Its study necessitated a fair knowledge of organic or inorganic chemistry, a knowledge of metallurgy, and of the fundamental laws of mechanics. In manufacturing there are three important considerations:

*Oxidation.*—The agents generally employed are chlorates and nitrates, their object being to promote combustion after heat is applied.

*Influencing Agents.*—Those which regulate the combustion, as sand or potassium sulphate.

*The Active Ingredient.*—To give the color desired.

Camphor and lycopodium are used in theaters; potassium nitrate with lamp black for golden stars, copper filings for green, and zinc for blue, etc.

Of fireworks there are four kinds: (1) Single—example, the squib; (2) terrestrial—placed on the ground—as mosaics and waterfalls; (3) atmospheric, as the rocket and Roman candle; and (4) aquatic.

COMPOSITION.—*Rocket:* Sulphur, 1 part; carbon (charcoal), 2 parts; nitrate of potassium, 4 parts; meal powder (as a diluent), 1 part.

*Roman Candle:* Sulphur, 4 parts; carbon, 3 parts; nitrate of potassium, 8 parts.

*Pin Wheel:* Base—Sulphur, 5 parts; nitrate of potassium, 9 parts; meal, 15 parts. Color as desired.

*Bengal Lights* (poisonous).—Realgar or orpiment, 1 part; black antimony, 5 parts; red lead, 1 part; sulphur, 3 parts; nitrate of potassium, 14 parts.

COLORED FIRES OR STARS.—*Blue:* Chlorate of potassium, 8 parts; calomel, 4 parts; copper sulphide, 5 parts; shellac, 3 parts.

*Green:* Barium salt, 16 parts; chlorate of potassium, 16 parts; sulphur, 5 parts; charcoal, 1 part.

*Yellow:* Oxalate of sodium, 2 parts; chlorate of potassium, 4 parts, with shellac.

*Mauve:* Chlorate of potassium, 28 parts; calomel, 12 parts; shellac, 4 parts; strontium nitrate, 4 parts; copper sulphide, 2 parts; stearin, 1 part.

*Purple:* Chlorate of potassium, 16 parts; copper sulphide, 8 parts; calomel, 7 parts; sulphur, 2 parts.

Different shades are obtained by slight variation in composition.—*Chem. and Drug.*

## CLOISONNE AND CLOISONNE MAKERS IN JAPAN.

ENAMELS, whether they may be those known as champleve, or cloisonne, or the variety which reached its highest perfection in Limoges in the middle ages, have for centuries been sought after by connoisseurs who loved to possess beautiful and costly objects of art, by the devout who would devote them to religious purposes, and by the vain to use for personal adornment. All ages and all countries can furnish relics of this old and beautiful art, and in the tombs of the Homeric heroes at Mycenæ, in the jewelry adorning the mummies of ancient Egypt, and in the brooches and tiaras of the old Celtic kings are found exquisite and priceless examples of enameling on copper and gold. It is in fact scarcely possible to mention a period up to the present when enamels were not produced either in the East or in Europe. From the time of Justinian till the middle of the sixteenth century enamels were introduced freely into the elaborate and costly decoration of the reliquaries, crosses, censers, etc., used in the ceremonials of the church, as well as in the ornamentation of girdles and weapons of the nobles and warriors of those days. In the seventeenth and eighteenth centuries the art suffered decadence in Europe, but the wonderful exhibits in the jewelry and orfèvrerie departments of the French section of the great exhibition in Paris in 1889 sufficiently demonstrated that the French at least among the nations of Europe still understand the mysteries of the art of enameling on metals, and can produce champleve and cloisonne enamels as fine as any ever produced in the middle ages in Europe or in the Orient, provided that buyers can be found willing to pay the high prices such costly and artistic work demands in Europe. The hands of European artisans are indeed no less skillful than those of China and Japan, and the artistic minds which direct them can conjure up creations as beautiful as those of the Orient; but the standard of comfort and the cost of living of the European artisan of to-day is so much higher than that of his Eastern fellow worker that high wages have driven many art industries entirely into the hands of the simple-living and humble-minded workers of the East. Thus the making of enamels exists only as an organized industry at the present time in China and Japan.

Among the many art treasures which were brought to light at the sacking of the Summer Palace in Pekin in 1859, and which subsequently served as models in European porcelain and pottery factories, and aided in reawakening an enthusiasm for the beautiful products of art industries, were some cloisonne enamels on copper of the Ming dynasty. These are the oldest Chinese enamels extant of which we have any knowledge, and they probably date back from 300 to 600 years. That the Japanese learned the art of cloisonne enamel from the Chinese is not disputed, and the tradition is that one Hirato Hikoshiro by name introduced the art of cloisonne making into Nagoya toward the end of the sixteenth century. Here for 300 years the industry has flourished, and Nagoya is still the place in Japan where there are the largest number of cloisonne workshops, and where Hondo and Shippo turn out a number of the vases and plaques which find their way to Europe.

The process of making cloisonne enamel is simple, minute, and laborious. It is briefly thus. The design is first sketched on the copper surface of the vase or plaque to be decorated. Strips of flexible copper about a millimeter in width are then bent with small pincers to correspond to the lines of the design, and are affixed edgeways on to the copper surface by means of a strong glue cement made from the bulb of an orchid, the *Bletia hyacinthina*. When the cement is dry the cloisons are soldered to the base. It may interest mechanics, both professional and amateur, to know how the Japanese make their solder. Eight parts of brass, seven of tin, and ten of zinc are melted together. This alloy is then pulverized, and ten parts are mixed with three of borax and sufficient water to make a pulpy paste. This paste is applied with a stick to the parts to be soldered together, and they are heated over a moderate coal fire till the solder melts. With the cloisons thus firmly attached the article passes to the enamelist, who fills up the cells with a material of various colors. In the older Chinese and Japanese enamels the mineral coloring matters were mixed with other ingredients and fused together. This method of working resulted in producing the opaque and dull coloring which some connoisseurs affect to greatly admire. Much of the modern Japanese cloisonne is, on the contrary, singularly pure and transparent in color, and these effects are produced by stained glass being used for fluxing instead of pulverized mineral colors. The glass is ground fine and mixed with water to form a uniform paste. Furnished with little saucers containing the various colored pastes to be used, the worker sits on the floor before a low box table which carries his materials for work, and, dipping an ivory stylet into one or other of the saucers of paste, applies the flux atom by atom to the interior of the cells. When the cells are filled the enamel is left to dry in the open air, and when air-dried is baked in a closed muffle. The enamel shrinks greatly in the oven, and air bubbles and holes appear. The article is then returned to the workshop for the cells to be refilled, and after the second baking it is rubbed down and polished. These successive processes of filling, baking, and rubbing down are repeated several times, till the hard and polished surface is flush with the cell walls, which appear as narrow metal bands separating the various colors and tints of the enamel. The successive polishings are accomplished with different materials—coarse and fine sandstone, slate, and magnolia charcoal being used after the second, third, and fourth burnings, with rape oil and hartshorn ashes. The last layer of enamel is applied as a thin coating after the final burning and polishing to give luster and brilliancy. In cloissonne enamels representing pictorial effects the metal cell walls are finally covered and buried in the enamel, except where it is considered advisable from the artistic and picturesque point of view to leave them exposed. The master of this special form of cloisonne enamel is Namakawa, of Tokio. Cell enamel on porcelain, for which the Japanese are so celebrated, is produced in the same way as above described, except that the soldering is omitted, which in fact is often also done in copper enameling.

The finest examples of modern Japanese enamels are rarely seen in Europe; they go to America, our cousins across the Atlantic being willing to pay for a gem of workmanship the price which such minute and artistic work demands. The wondrous enamel pictures of Namakawa, of Tokio, seen when I first arrived in Japan at Mr. Deakin's at Yokohama, and at the art exhibition at Tokio, filled me with the desire to see this artist's workshop and to understand how such subtile and pictorial effects were produced by means of a process so apparently intractable as that of cloisonne enamel. By the kindness and courtesy of Captain Brinkley I was enabled to fulfill my wish, to be thus only the second European who had visited the little workshop from which such surprising and delightful art work is turned out. Let me try and realize to you what Namakawa's, of Tokio, cloisonnes are like. I will describe one in the possession of Mr. Lowder at Yokohama. It is a picture about 18 inches by 12 in size, and the subject is a winter landscape. The low rounded hills are covered with snow, from which rise the dark stems and gaunt branches of a few fir trees; the sky tones are from the cold pale blue of a winter's day to the tender pinks of sunset. Below the snow-covered hills is a calm, deep lake, the waters of which have that peculiar cold, steely gray color characteristic of lake water on a snowy day. Across its still surface steals a solitary little skiff. The repose, the tender coloring, the truthfulness to nature, and the suggestiveness of this charming impressionist picture—worked in solid imperishable enamels—are quite delightful, and no one but a Japanese could have conceived and executed it. Take another piece of Namakawa's work which I saw, says Mrs. Hart in the *Manchester Guardian*, in Mr. Deakin's collection at Yokohama, and had photographed. Two pigeons are represented against a background which shades from rosy orange to gray. The fluffy plumage of the birds' breasts, the iridescence of the feathers of the dark pigeon, and the yellowy shades of the white one are given with a skill vying with the painter's art. Yet another example from the same interesting collection of all that is best of modern Japanese art. It is a small tray measuring ten inches by five. On the upper surface is represented a goldfish swimming under the water. A flux of transparent bluish enamel incloses and covers the scaly fish, which is exquisitely wrought in pure gold. A few reeds below and a water plant floating on the surface give reality to the illusion. A geometrical design in dull blues, browns, and reds covers the back of the tray. This little gem of workmanship was going to Dr. Williams, of Philadelphia, and cost 75*l*. Namakawa's workshop at Tokio, where these objects of art are produced, is simplicity itself. Opening freely by the sliding paper panels on to the pleasant little garden are the rooms where the work of attaching and filling the cells is carried on. About six workmen are in each room. Seated on their heels on the matted floor, they are busy dipping their ivory stylets into the various saucers of colored pastes and applying the atoms of enamel to the cells, thus obtaining, by laborious care and artistic taste, the graduations of tint and tone so much admired in Namakawa's products. The enamels turned out from this little collection of workshops are so good that it is to be regretted that Mr. Namakawa does not always select the best models and designs for his workpeople, but is sometimes content with designs of a lower grade. I do not think he need have any fear but that the best work of which he and his workpeople are capable will always find ready purchasers in Europe and America, and he can leave the production of cheaper qualities and inferior designs to other workshops. Every piece, moreover, that comes from Namakawa's workshop should bear his signature, so that the picture enamels of Namakawa of Tokio should be as well known, as much sought after, and as verifiable as the cameo glass of Gallé of Nancy.

As the name of Namakawa of Tokio immediately suggests one kind of cloisonne enamel—the representation of poetic impressionism—so the name of Namakawa of Kioto suggests a totally different kind of cloisonne enamel, namely, that of intricate formal design and of brilliant coloring. The cloisonne vases seen in the shops of the curio dealers in England are poor imitations of the work of Namakawa of Kioto, and I do not think that genuine examples of his work are ever offered for sale in England. To see and realize the perfection and delicacy and finish of Namakawa's work a visit must be paid to his workshop in Kioto. Seated on the matted floor are the workpeople, closely occupied in filling the cells of the objects in their hands with the brilliant enamel pastes which Namakawa holds the secret of making. The spring day is warm and bright, and the paper wall panels of the workroom are slid back, giving a view of the trees and flowers of the garden beyond. After photographing the group of artist workmen in their pleasant airy workroom I stepped out into the sunny garden and passed under the cherry trees powdered over with blossoms of pink and white, across the miniature stone bridge, and around the tiny borders of the tiny lakelet, in the placid waters of which tame golden carp as large as salmon trout floated lazily, and came to be fed by Mr. Namakawa, who, standing on the balcony above, clapped his hands and sprinkled biscuits in the water for his piscatorial pets; and thus I sanntered on through this pleasant little garden, full of poetic suggestions and significant of a life of artistic refinement, which led from factory to showroom. What an ideal factory! No smoke, no noise, no hurry. Engaged in the pursuit of a delightful art, the workmen have but to lift their eyes from their work to see the cherry blossoms tossed up against the blue sky, the stone temple lamp found in every Japanese garden suggest-

ing thoughts of the spirit world around and beyond us, and the little lake in which the fat carp contentedly live out a long life of leisure. Mr. Namakawa conducts us with many polite bows to the little showroom, where we carefully examine his masterpieces of delicate workmanship. His cloisonne differs from that of all other enamelists in perfection of finish and in the transparency and brilliancy of color. His apple greens and reds are particularly fine. The designs are generally geometrical and formal. Dragons and kylins and birds are freely introduced into medallions which are linked together with florid curves and lines. The designs are, in my opinion, often overcrowded. His imitators, of whom there are many, overcrowd still more, but they fail in finish and in the transparency and brilliancy of the enamel fluxes.

Ikeda of Kioto produces cloisonne enamels equal in quality to those of Namakawa, of the same city. A visit to Ikeda's showrooms and workshops is one of the pleasant incidents of a stay in Kioto. Set down by the fast-running jinrickisha men at a plain wooden house, the paper windows of which are protected by wooden grills, the only objects which externally indicate that this is a depot for curios are two immense bronze vases which nearly block up the doorway. Though so large, they are masterpieces of cire perdue casting, and on their broad surfaces the metal lotus leaves lie as if just moulded in wax. The showrooms beyond are wide and spacious, and under the guidance of Mr. Ikeda's son, a polite and intelligent youth, who speaks fairly good English, and who does not hesitate to consult a huge dictionary if he fails to understand you, we examine the most beautiful and costly specimens of modern Japanese art, and which are displayed on low tables. Finding that his visitors appreciate the art and workmanship of the objects shown, the fireproof *go-down* is opened, and one by one its treasures of gold lac, of damascene work in silver and gold on iron, of carved ivory cabinets and of cloisonne enamels are brought out and laid down on the floor before us. They are indeed wondrous examples of exquisite workmanship, of artistic conception, and of delicate skill, and demonstrate (if such demonstration be needed) that modern Japanese art work is as fine as it ever was, and is as worthy of the love and admiration of the connoisseur as the damascene and niello work of Nuremberg, the enamels of Limoges, and the porcelain painting of Sevres. But admiration signs no checks; so, failing the power to possess, the next best thing is to obtain the knowledge how these treasures are produced. Ikeda's workshops are on an upper story, the balcony of which overhangs the garden, in which great bronze storks stand among the blossoming cherry and tulip trees, and bronze dragons drink out of magnificent vases, or the mythical kylin disports itself on koros, marvels of cire perdue casting. The workshops are four in number. In one fine cloisonne enamels are being made, in another modern Satsuma porcelain is being covered with delicate paintings, in a third the process of making gold lac can be studied, and in the fourth damascening. In this last workshop fine gold and silver wire is hammered cold into iron vases, plaques, etc. Some remarkable pieces were in hand. A large circular dish decorated with chased raised figures of lakans and dragons was being damascened. It will probably take about four years to complete, and when finished will cost about 300*l*. The gold wire used was extremely fine. To make it the gold is first beaten into a thin sheet, it is then cut into strips with scissors, and rolled on a small smooth metal plate by means of a spatula. A workman was at work cutting and rolling strips of this gold wire, which is finer than a hair and can be seen only with difficulty; but taking up a piece he solemnly presented it to me, saying quietly, "Take this and show it to your country." I have tried to follow this workman's behest, and have taken all I could gather in a delightful and memorable visit to Japan of impressions of her living art, of the poetic perceptions, the rare skill, the patient industry, the simple lives, and the beautiful products of her art workmen, and to give them to my country; and those who have read my letters describing some of the art industries of Japan of to-day cannot, I think, have failed to feel how much we can learn from the happy, simple, and artistic workmen of the Land of the Rising Sun.

## LARRANAGA'S PHOTO-PHONOGRAPH.

By JULIUS MAIER, Ph.D.

A MOST ingenious apparatus for recording and reproducing speech has been devised by Mr. Luis Larranaga, of Lima, Peru. It occurred to Mr. Larranaga that in all the instruments used in recording speech, an imperfect fixed record of the human voice had hitherto been produced by attaching an indenting instrument or needle to a diaphragm caused to vibrate by the waves of sound set in motion by the human voice, and, if needs be, collected and re-enforced by a resonance box. The indenting instrument or needle in a state of rest is in contact with or in close proximity to a revolving cylinder, or other sound recorder, and produces, at every vibration of the diaphragm, a more or less deep indentation on the soft material coating the cylinder. It is clear that for every forward movement of the membrane a corresponding backward oscillation must ensue, the membrane must return to its normal position, or practically so, after every oscillation, otherwise the result of the next succeeding oscillation would produce no perceptible effect on the material coating the cylinder. The records of the human voice hitherto obtained, Mr. Larranaga considers, only represent the forward oscillations of the diaphragm, while the corresponding backward motions, which naturally depend as much as the forward ones on the characteristic properties of the voice, are partly unrepresented in the tracings obtained on the cylinder. To this defect Mr. Larranaga ascribes the imperfection of reproduction with the ordinary phonograph, and proposes to remedy this defect, as far as this latter instrument is concerned, by fixing the stylus attached to the vibrating diaphragm to an articulated lever, carrying, at its lower extremity, a segmental cross piece, at either end of which a tracing pin is fixed at opposite corners. The forward vibrations of the diaphragm will now cause one of these tracing pins to be pressed against the cylinder, while the backward pulsations will have the same effect on the second tracing pin, and the tracings made on the cylinder will now represent the movements of the diaphragm in their entirety, they will be a faithful record of all the inflections of the human voice, and will furnish a perfect reproduction of the sounds emitted before the membrane.

This, however, is rather in the way of a digression from Mr. Larranaga's actual invention. He deals with the difficulty just mentioned in an entirely different and much more ingenious way.

He causes the waves of sound to impinge against a sensitive flame, or against the diaphragm of a gas telephone having a lighted gas jet or flame, thereby varying the degree of its luminosity. By a suitable clockwork he then causes a bichromatized gelatine plate to travel in front of this flame, the action of which will decompose the bichromatized gelatine and produce, after development, on the part of the film exposed, a

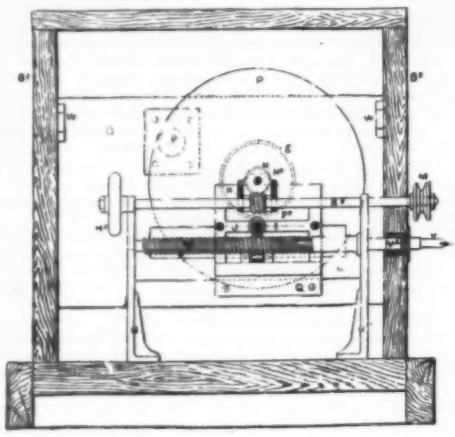


FIG. 2.

line indented more or less deeply, according to the luminosity of the flame.

The instrument certainly is one of the most beautiful illustrations of the equilibrium and the unity of natural forces—an equilibrium so nicely balanced that no change, however slight, can take place in one of them without producing a corresponding change in the other. We have here an instance of manifold conversions of energy, scarcely, if ever, equaled in the history of invention. To make the matter perfectly clear to the reader, let us enumerate these conversions:

1. The organs of speech produce sonorous vibrations, which, impinging upon the diaphragm, give rise to oscillations in the latter.

2. The vibrations of the diaphragm cause an alternate increase or decrease of pressure in a gas chamber over the bottom of which the diaphragm is stretched.

3. The luminosity of the flame fed by the gas contained in the chamber is increased or diminished according to the variations of pressure.

4. The light of the gas jet is, by means of a reflector and a lens, thrown on a bichromatized gelatine plate.

5. The bichromatized plate is decomposed more or less energetically, according to the variations of luminosity of the gas flame.

6. By the action of the light the bichromatized gelatine is rendered insoluble.

7. By a dissolving agent the undecomposed bichromatized gelatine is removed—*i. e.*, that portion of the coating of the plate which has not been acted on by the light, and a spiral line is left on the plate in more or less strong relief. This spiral curve may be pronounced a perfect record of the sounds emitted before the diaphragm.

8. By the action of a stylus attached to a second diaphragm and moving over the spiral line traced on the plate, while the latter is being rotated, this diaphragm is thrown into vibration.

9. By the vibrations of the second diaphragm the air is thrown into sonorous vibrations perceptible to the human ear.

Mechanical energy is thus converted into luminous energy, luminous energy is transmuted into chemical energy, and this latter reconverted into mechanical energy

Having now stated the principles underlying Mr. Larranaga's invention, we proceed to give a description of the apparatus itself, illustrated by the accompanying cuts.

Fig. 1 is a longitudinal section of the apparatus; Fig. 2 is a section on the line Y—$Y_1$ of Fig. 1. The same letters of reference are used to denote the same or corresponding parts in both the figures.

T is the mouth piece connected by means of a flexible tube, $T_2$, with the resonance box, A. Across the top of this box is fixed a vulcanite diaphragm, D, which forms the bottom of the gas chamber, G. The gas is passed into this chamber through the supply pipe, $G_2$, at a steady moderate pressure, the pressure being regulated by any suitable mechanical means, and issues through the burner, $F_2$, and when lighted gives a small steady flame, shown at F in the diagrams. As the waves of sound impinge against the diaphragm, D, it is thrown into vibration, thereby varying the pressure of the gas within the chamber, G, and causing the light of the flame issuing at F to be increased or diminished in intensity.

The rays of light from the flame, F, are collected by the reflector, R, and are thrown on the lens, L, by which they are focused into the interior of the box, $O_2$, having a small aperture, O. The reflector, R, and the lens, L, are capable of being adjusted as circumstances require. The box, $O_2$, is attached to the partition, B, which divides the outer case, $B_2$, into two parts. The partition, B, is held in place by guides, G—$G_2$, and is kept away from the disk, P, by means of two cam levers, W, pivoted on each side of the outer case, $B_2$, as shown in Fig. 2. On the side of the disk, P, nearest to the partition, B, the bichromatized gelatine plate is fixed, and contact between the box, $O_2$, and the bichromatized plate is prevented by means of the cam levers, W. By focusing the light into the box, $O_2$, and carrying the said box forward until it nearly touches the bichromatized plate, as shown in Fig. 1, the beam of light issuing from the small aperture, O, is prevented from losing any of its rays by divergence. That part of the outer case within which the bichromatized plate is placed is made light proof, the only light admitted being that passing through the small aperture, O; this precaution is necessary in order to prevent the decomposition of the bichromatized gelatine by any other than the light admitted through O.

The disk carrying the bichromatized plate receives a double motion, viz., it is rotated on its axis and is at the same time caused to travel from the circumference to the center, or *vice versa* across the aperture, O, of the box, $O_2$, so that the indented line produced by the action of the beam of light on the bichromatized plate will be a spiral line. This double motion is produced by the following mechanism:

The disk, P, is fast on the spindle, $H_2$, which rotates in bearings, $H_3$, carried by the slide rest, Q. H is a worm wheel keyed on the spindle, $H_1$, and gearing with a worm, K, sliding on a feather on the transverse shaft, $K_2$. This shaft, $K_2$, is supported in bearings on the uprights, U—U, and is provided at one end with a hand wheel, $H_2$, by means of which it may be rotated when it is necessary to adjust the disk, P, by rotation. The other end of the shaft, $K_2$, passes through the side of the outer case, $B_2$, and is provided with a pulley, M, driven by the strap, $M_2$, from the hand wheel, N.

On the disk spindle, $H_2$, is keyed a toothed wheel, E, gearing with a pinion on the parallel spindle, $P_2$. On the spindle, $P_2$, is keyed a worm, I, which gears with the worm wheel, J. This worm wheel, J, is in the form of a nut on the screw shaft, V, which rotates in bearings on the uprights, U—U, and parallel with the shaft, $K_2$. The end, $V_2$, of the screw shaft, V, is squared and protrudes partly through the side of the outer frame, B, and over this squared end a key, V, may be placed, and the screw shaft thus rotated when

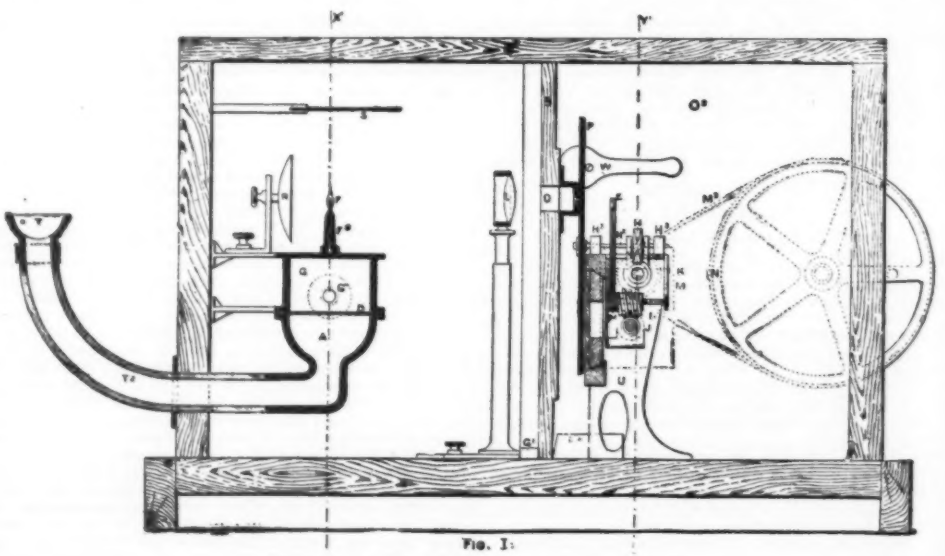


FIG. 1.

## THE PHOTO-PHONOGRAPH.

it is desired to adjust the disk, P, from the center to the circumference, or *vice versa* across the aperture, O, of box, $O_2$.

The action of this mechanism is as follows:

When the hand wheel, N, is rotated, the pulley, M, shaft, $K_2$, worm, K, and worm wheel, H, are also rotated. This causes the rotation of the spindle, $H_2$, and disk, P. At the same time the toothed wheel, E, rotates the pinion, $P_2$, thus causing the rotation of the parallel spindle, $P_2$, worm, I, and worm wheel and nut, J, on the screw shaft, V. As the screw shaft, V, is normally stationary, the nut, J, will travel along to the right or left according to the direction of the initial rotation of the wheel, N. The worm wheel nut, J, carries the slide rest, Q, which carries the bearings for the spindles, $P_2$ and $H_2$, therefore, as the nut, J, trav-

ets along the screw shaft, V, it will carry with it the whole of the gear, and will move the worm, K, on the shaft, $K_2$. The slide rest, Q, travels in a groove in the frame, Z. When the screw shaft, V, is rotated by the key, V, the nut, J, will be made to travel longitudinally, without rotation on the screw shaft, V, and the position of disk, P, may be thus adjusted without rotation when such adjustment is required.—*Electricity, London.*

## THE BENARDOS-HOWARD ELECTRIC WELDING PROCESS.

A LARGE party of gentlemen recently visited the works of Messrs. Lloyd & Lloyd, the well-known tube makers, at Old Hill, Birmingham, by special invitation, to witness the working of the Benardos-Howard electric welding process.

These works, says *The Engineer*, cover part of an estate of about thirty-five acres. Fig. 1 is a plan of the estate, from which it will be seen that attention has been paid to the wants of the workmen, of whom about 1,000 are employed, and many live in the cottages shown to the left of the plan, where a playground is

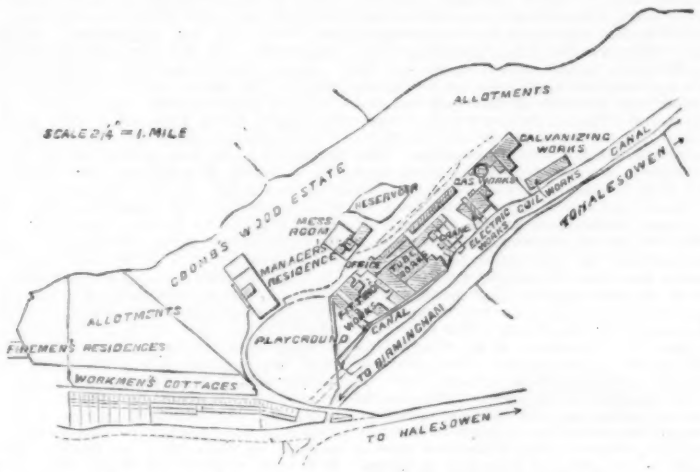



FIG. 1.—PLAN OF COOMB'S WOOD ESTATE.

provided for the children. We are informed that the average stock kept at the Coomb's Wood Works is about 200 miles of finished tubes. The machinery throughout the works is driven by engines developing 400 to 500 indicated horse power, the electric light is largely employed, and ventilation is effected by means of three Blackman air propellers. In order to insure soundness in the tubes, a hydraulic system is in use for testing, and a pressure of 800 lb. per square inch is kept up, which by means of intensifiers can be increased to any pressure that may be required.

Messrs. Lloyd & Lloyd also employ from 200 to 300 men at their works in Birmingham and elsewhere in the manufacture of lap-welded tubes and coils of all kinds, and these works are all connected to the offices by means of the telephone, where tape-printing telegraph instruments are also employed. We believe that this firm was the first to manufacture large welded iron tubes by the gas process, which has been since used by Mr. Samson Fox for his well-known corrugated flue tubes.

Until recently, however, there has always been a considerable amount of waste, owing to the breakage of tubes when undergoing the process of being made into bends and elbows. With a view of effecting a saving in the cost of welding, and of obtaining a clear heat, the attention of Mr. Henry Howard, of Stonehouse, Kidderminster, one of the partners in the firm, was directed to the Benardos electric welding process, which has been for some time used in Russia. Mr. Howard has taken out many patents for improvements to the process, and the success which has now been obtained is greatly due to his exertions. A plant was obtained, and Messrs. Lloyd & Lloyd secured the sole right to use the process in Great Britain. At first three Russians were employed to carry on the work, but in a very short time it was found possible to educate ordinary laborers to take charge of the welding plant, and for some time past no foreigners have been engaged in the works.

The process employed is quite different from the

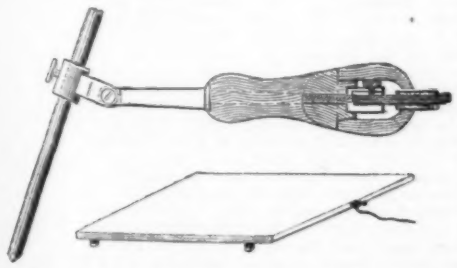


FIG. 2.—CARBON HOLDER AND TABLE.

Thomson-Houston method. The latter consists in causing a current of electricity to flow through the two portions of metal which are to be united, and owing to the high resistance of the imperfect junction of the two parts, the joint is raised to a welding temperature. This process is, therefore, particularly applicable to wire welding, and to objects which are comparatively long in proportion to their sectional area; the Benardos process, however, consists in causing an electric arc to be formed between the metal to be welded and a carbon pencil similar to those used in an arc lamp. Fig. 2 shows the method of holding the carbon, which can be moved about readily by the hand to any suitable position.

The object to be welded is connected to one pole of the source of electrical energy, and the carbon to the other. On commencing work it is necessary first to allow the point of the carbon to touch the work in order to start the arc; the carbon is then moved to a distance of from 1½ in. to 3 in. from the work, according to the potential employed, and we were informed that arcs 6 in. long could be obtained in welding iron. It may be noted that the carbon is the negative pole, and, as Professor George Forbes remarked, it is doubtless due to the iron becoming vaporized that the long arc is obtained. This suggestion is well borne out by the long arc which Mr. Ferranti has obtained, by placing a thin iron wire in the axis of the positive carbon of an ordinary continuous current arc lamp. Fig. 3 shows the general plan of connections from the dynamo to the welding tables, and it will be seen that it is necessary to provide an adjustable resistance coil for each welder, for the same reason that resistances are used in arc lamp circuits in order to obtain a steady arc.

In the welding shop at Coomb's Wood Works the power is produced in the first instance by a compound condensing engine built by Messrs. Davey, Paxman & Co., and indicating 100 horse power, according to diagrams taken by Mr. Henry Lea, C.E., who is the consulting engineer to Messrs. Lloyd & Lloyd. This engine drives by means of link leather belting three continuous current shunt-wound dynamos, built by Messrs. Crompton & Co. Two of these machines develop 300 amperes each, the third 200 amperes, all at 150 volts. The commutator brushes are of thin copper plate; but an additional strip is provided with carbon ends, to diminish the sparking caused by sudden changes of load. The switch room contains the ordinary measuring instruments, field magnet coil resistances, etc. The battery room, which is a notable feature in the arrangement, contains 1,800 cells of the Benardos type. These cells are placed on varnished wood frames, in five tiers one above the other, and are coupled in series of fifty, so that a very large current output can be obtained. The cells themselves are of glass, and are 10 in. high by 7 in. wide and deep; each cell contains four positive and five negative plates of the type shown in Figs. 4 and 5. Fig. 4 shows the lead frame, which is first cast, then thin strips of lead alternately flat and corrugated are placed vertically inside the frame, and the ends are burnt on by means of the electric arc, a very small carbon and moderate current being used, and it requires only a touch of the carbon point to fix the ribbon in place. In this case the current flows from the carbon which is the positive pole to the lead grid. It will be noticed that there is a strong resemblance between this plate and the D. P. plate made by Messrs. Drake & Gorham. In the latter, however,

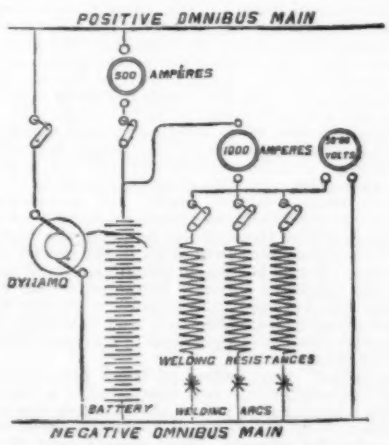



FIG. 3.—DIAGRAM OF WELDING CONNECTIONS.

the ribbons of lead are horizontal when in position. The plates used in the Benardos cells are all alike, and no paste is used. They are not formed in any way before being put into use, but while in use are from time to time connected in alternate directions with the dynamo. This form of cell has been found specially adapted for electric welding. The welding machines in use consist of one special machine with a gyrating carbon, four welding tables, and one lathe, two mending tables, and four lead welders. The amount of current required for these is roughly as follows:

| | Amperes. |
|---|---|
| Gyrating carbon machine | 300 |
| 4 tables at 200 amperes | 800 |
| 1 welding lathe | 300 |
| 2 mending tables at 50 amperes | 100 |
| 4 lead welders at 15 amperes | 60 |
| Lighting of building | 150 |
| Total amperes | 1,710 |

As the output of the dynamos is, as before stated, only 800 amperes, this leaves 910 to be made up by the battery, supposing all the machines to be at work at the same instant. It is found, however, that as the work is intermittent the engine can be kept at full load, and the current is stored in the cells when the tables are not in use.

During our visit the reservoirs for containing the compressed air for the Westinghouse brake were being welded upon the gyrating carbon machine. These are made of wrought iron, No. 10 S. W. G.; they are 2 ft. long and 10 in. diameter, and are lap welded. The carbon is made to gyrate in order to get a larger surface heat. The lap is first welded at each end of the cylinder for a distance of about 4 in. These welds are allowed to become cold, after which the rest of the seam is welded in about four heats.

On the first application of the arc the surface of

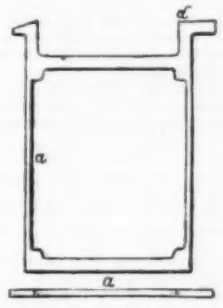



FIG. 4.—FRAME OF LEAD PLATE.

the iron melts, and it has the appearance of being covered with melted borax, but no flux is used. The molten iron runs between the joint, and when the welding temperature is obtained, the cylinder is slipped along the semicircular anvil on which it rests, and the joint is hammered by a Player's mechanical hammer with the well-known air-cushioned head. The seam, 2 ft. long, can be welded up in about nine minutes. Two men are required to manipulate the work, and the positive cable is held on to the reservoir by means of a pair of ordinary tongs. The ends of the reservoir are afterward put in by the same process.

It may be pointed out that iron of 18 or 20 gauge is easily welded without being injured, and is made into petroleum casks. The process of cutting out plates of any shape by means of the arc was then shown. The carbon is preferably held under the plate, so as to allow the molten metal to fall away. Holes can be drilled in this way also, and it is quite possible to do this work under water. In the case of large tee joints of pipes of 10 in. or 12 in. diameter, a portion is cut out of one pipe by means of the arc, the end of the other piece is then cut to shape by the arc, the two are put together and roughly tacked, the joint is then raised to the requisite heat, and small pieces of iron are welded into it until a perfectly sound junction is made. Many beautiful examples of this class of work were exhibited in the sample room, in some cases pipes of 1½ in. diameter being welded into large thin pipes of at least 12 in. diameter.

The process of repairing a broken pump rod was also shown. The fracture had taken place where the hol-

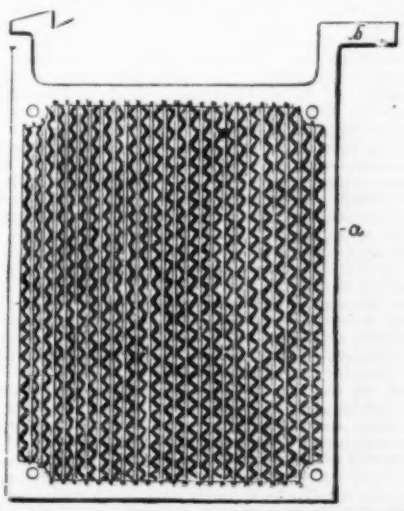



FIG. 5.—LEAD PLATE OF BENARDOS CELL.

low wrought iron tube 5 in. external diameter and ¼ in. thick had been joined to the solid end at the bottom. The arc was used to raise the broken part to a welding heat, after which small wedges of iron were welded into the crack. The welding lathe is used to put flanges on tubes. Short ends of tubes, about 4 in. diameter and 6 in. long, were being operated upon during our visit. The tube was chucked in an ordinary face plate with the flange end outward, and while the lathe was rotating the carbon was applied, and an arc about 2¾ in. long formed. The joint was heated to welding temperature all round, and was finished off by

means of a roller of suitable form brought up to the flange by means of a slide rest.

Some large wrought iron water tubes were exhibited, 26 in. diameter and ⅛ in. thick, which had been welded longitudinally by this process. The end joints were made by means of riveted angle iron. These tubes are intended for a colliery at Muki, in Japan, and have spigot and faucet joints. They are part of a large plant, consisting of two of Davey's compound differential pumping engines of 500 horse power each, built by Messrs. Hathorn, Davy & Company, of Leeds.

A cast iron shrouded pinion was also shown, into which two new steel and three cast iron teeth had been welded to replace broken teeth.

Passing now to the sample room, among many other specimens we may select Westinghouse brake reservoirs, which had been tested by hydraulic pressure to destruction, and had burst at from 700 lb. to 750 lb. per square inch, then giving way at the ends, but through the solid metal and not at the welds. Steel files had also been welded, and many varieties of difficult tee joints and thick flanges welded to thin tubes.

In order test the relative value of the electric welding process in comparison with the solid metal, and also with the best class of smith's weld, investigations were carried out by Mr. Henry Lea in conjunction with Messrs. David Kirkaldy & Son, of London, and for this purpose 210 bars of varying thickness and qualities of iron and steel were electrically heated and welded by ordinary unskilled workmen, and were compared with fifty bars welded by good engine smiths in a coke fire.

The average ratio of weld to solid of the 150 iron bars electrically welded was 85·5 per cent. and of the sixty steel welds 80·8 per cent.; in each case the average of ten welds was taken.

This electric welding process is, we believe, capable of wide application, and the faces of the weld are not subjected to the danger of becoming covered with dirt.

## ALTERNATING ELECTRIC SYSTEMS AND THEIR PHYSICAL HAZARDS.*

By GEORGE P. LOW.

IN entering upon a discussion of alternating electric currents and their hazards it is meet that their purpose should be explained. Why is it that the alternating system, with its extremely high voltages, fatal to life and possessing hazards to property peculiar to itself, should be used for purposes of interior illumination when the ordinary incandescent systems furnish equally good service, are incapable of inflicting even temporary injury to human beings, and are without certain hazards possessed only by the alternating system? At a first thought it may appear to the laymen that alternating systems have no legitimate excuse for their existence, and that their use by electric lighting companies instead of the ordinary low potential systems exposes the public to unnecessary hazards. So far as the property or fire hazard is concerned, such an idea is entirely wrong, for, as will be shown, honors are about evenly divided between the hazards of the two systems. If the alternating system has a hazard that the low potential system does not possess, the latter also has a hazard peculiar to itself, and from which the use of alternating apparatus is exempt, but whichever system is used the attending hazard may be reduced to an iota, if not eliminated, by devoting proper care to every detail of installation. I do not consider the hazard of a poorly constructed installation to be greater than that attending the use of oil as an illuminant, and I do consider that, next to the sun, a properly constructed incandescent system is the most perfect system of illumination, either natural or artificial. As has been previously stated, to obtain light, heat must be generated, and no matter in what is its condition, the energy capable of creating a light-giving temperature direct may prove incendiary. Even the light and attendant heat of the sun has caused fires. Strictly speaking, therefore, there is no such thing as an absolutely safe illuminant, unless it be the light of the moon or stars, which would hardly satisfy the exactions of our civilization. All methods of producing light artificially have elements of danger. Some of their hazards are great and some are only moderate, yet in electricity is found a light-producing energy that can be used with the least danger of all—and it is quite immaterial whether this opinion be applied to the light produced by the low potential or "direct" system, or from alternating circuits. The only requisite is that the circuits and apparatus be properly installed.

In the electrical exhibition at Frankfort, Germany, are incandescent lights and pumping machinery operated by dynamos driven by water power at Lauffen, 110 miles away. Although 300 horse power is transmitted that distance, yet three copper wires, each less than one-eighth of an inch in diameter, are sufficient to carry the energy consumed. The cost of installation is such that it could be undertaken by any electric lighting company of any large city, yet to obtain equal results under the same conditions by the low potential system would necessitate investments that would appall any capitalist, syndicate or government. The solution of the problem of long distance incandescent lighting is due, therefore, to alternating systems alone.

But let us turn to the nature, characteristics, and phenomena of alternating currents, and in so doing we will study an application of electricity which presents most interesting features and becomes more and more wonderful as the research is pursued. Continuous currents have characteristics rendering them indispensable for some applications, such as in electro-plating or in installations where storage batteries are used. Moreover, in the present state of the art electric power derived from continuous current circuits, either from constant potential or from constant current systems, is far more satisfactory and efficient than electric power derived from an alternating current. Indeed, alternating currents can never entirely displace the use of continuous currents in some branches of applied electricity, yet it requires no great foresight to reach the conviction that the energy of distant water powers can best be brought into the centers of population and industry by means of electricity in a state of ceaseless alternations. In the system then rests the idea that is not revolutionizing, but which is developing electricity into a more indispensable factor of civilization. It is singular that this, the latest development in the new science is but the perfection of the first form of dynamo electric machinery that was devised. Then, away back a generation or more ago, the few dynamos, or more properly speaking, the few magneto generators used produced alternating currents, but its peculiar differences from the then familiar galvanic electricity led to the invention of the commutator, by means of which alternating currents were communicated or rectified into continuous currents. Alternating dynamos are the simplest electric machines in existence. They consist merely of a coil of wire passing first in front of the positive pole of a magnet, then in front of the negative pole, then by a positive pole, and so on. As the coil passes one magnetic pole, a positive potential is generated, then, as it passes the opposite magnetic pole, an electric potential of contrary sign or a negative potential is generated, and so it goes on, alternating first positive, then negative, then positive, and so on, the number of these changes effected in a given time being the number of alternations of the dynamo. In the modern alternators these potential changes occur at a rate from 500 per second up, and, as previously stated, the almost inconceivable rate of 20,000 complete alternations per second has been attained in an experimental dynamo. Inasmuch as the mission of the commutator in dynamos is to rectify currents or to straighten them out, so that they shall flow in one direction, it must be plain that there is no need for such a device in the alternator. The armature consists virtually of but one coil of wire, each end of which is connected to a separate ring or collector, placed upon the armature shaft, and from which the current is taken by brushes. The field magnets of alternators are of peculiar form, and in most machines they consist of a massive circular or cylindrical iron frame, with pole pieces extending inward radially. About these pole pieces are coils of wire, through which is driven current, generated by a little independent continuous current dynamo, called the exciter, from the fact that its current excites or energizes the fields of the alternator. The necessity of this little dynamo will be recognized when it is understood that it is impossible to magnetize a bar of iron to a fixed magnetic polarity by means of an alternating current, as the magnetic pole changes synchronously with the alternations or directions of current flow. It is essential that the magnetic poles of the fields should alternate, the first field being positive, the next negative, and so on, and to do this a continuous current must be used, the current being carried around the iron core in one direction to produce a positive pole and in the reverse direction to produce a negative pole. The armature coils, in passing these alternating poles, generate the alternating current under consideration.

We now come to the vital feature of the system, namely, the converter or transformer, the study of which forms a succession of wonderfully interesting surprises, each more agreeable than its predecessor. Allusion has already been made to the belief that electricity and magnetism are but different manifestations of the same energy, and you all understand how readily interchangeable they are. Every wire carrying an electric current is surrounded by a field or atmosphere of magnetism which permeates the surrounding element in a whirling direction, no matter whether that element be air, the hand, glass, wood, metal or any other substance. In fact, there is no such thing as an insulator of magnetism known. We can insulate conductors carrying electricity very effectually, but magnetic lines of force permeate glass or a block of brass with about the same facility as they would traverse an equal distance through air. Perhaps coming generations will invent or discover an insulation that will be impervious to magnetism, but it is something we have not yet reached. As stated, these lines of magnetic force emanate from wires carrying currents as well as from the poles of magnets. If the current flows in one direction, the resultant lines of magnetism will have a given magnetic polarity or whirl, while if the direction of current flow be reversed, the magnetic whirls about the conductor will also reverse, and their magnetic polarity will consequently be changed. It follows then that when an alternating current traverses a conductor, the direction and polarity of the magnetic lines or whirls of force about it are changing with equal rapidity.

Again, suppose two wires are run along side by side for any distance, and that an alternating current is traversing one of them. In this event a secondary and entirely independent electrical potential will be created in the second conductor. No metallic connection exists between these wires, hence there can be no actual transfer of electricity from one to the other, but the phenomenon that does occur and which occasions a potential in the second wire constitutes induction. To more fully illustrate this, let us consider another experiment. Wrap a few hundred feet of wire into a flat coil and place it upon a table, covering the coil with a sheet of thick plate glass. On this glass, immediately over the first coil, place a second similar coil, connecting its terminals to an incandescent lamp, and on sending alternating current through the first coil, the lamp will burn from the current generated in the second coil by induction. If iron is brought into proximity of the two coils, the inductive action is increased, owing to the fact that iron affords a path of lower resistance for the magnetic lines to travel through, and that consequently a greater number of these lines or a greater magnetic intensity exists.

The earliest development of these phenomena appeared in the induction coil, consisting of a bundle of fine iron wires forming a core, about which was wound a comparatively few turns of insulated thick copper wire, called the primary. This arrangement thus far will be readily recognized as an electro magnet. Around the outside of this electro magnet is placed an insulating wrapping of paper or gutta percha, then over all is coiled a great many turns of insulated fine wire, called the secondary coil. It will be noted that no electric connection exists between the two coils—in fact, the higher the insulation between them, the better. Such is the construction of the induction coil, and now for its method of operation. Those who were present at the reading of the first paper of this series will remember that in speaking of the interchangeability of electricity and magnetism reference was made to the electro magnet, and it was shown how the iron was made magnetic by the circulation of a current of electricity through the coils surrounding it, and how an electric current would flow through the surrounding coils as the iron core became magnetized or demagnetized by some external means. Upon this fact rests the vital principle of the induction coil, and of its perfected form, the converter. In these the mission of the primary wire is to magnetize and demagnetize the core, in order that the magnetic rays emanating from the core whirl through the secondary coil, first in a given polar direction, then in the opposite one, and by so doing induce a current of electricity in the secondary coil. Converters, then, like dynamos, become generators of electricity, and to go into the subject a little deeper let us see just wherein they differ. Dynamos, as you are aware, consist essentially of an armature revolving between electro magnet pole pieces, across which pass lines of magnetism of fixed intensity. The wire on the revolving armature passes through or cuts this fixed magnetism, the potential of the armature wire is disturbed and an electric current is generated. Now for the converter. In it there is no moving or revolving armature wire. Instead of the wire cutting lines of magnetism as in the dynamo, the ever-varying lines of magnetism from the iron converter core dart out and whirl through the wires of the secondary coil, and current is generated precisely as in the dynamo armature. In the dynamo the wire cuts the magnetism; in the converter the magnetism cuts the wire, and the result is the same.

Again, it is necessary to revert to our first paper, and impress the statement then made that electric energy does not depend alone upon volts nor upon amperes, but upon their product, which gives us the unit of electric energy called the watt. The magnetic energy imparted to an iron core is, however, dependent upon the number of amperes traversing the surrounding coil, multiplied by the number of turns of wire in the coil, or, technically speaking, upon the ampere turns. Thus 10 amperes flowing about an iron core through 100 turns of wire gives 1,000 ampere turns, and the resultant magnetism will be the equivalent of that produced by ½ an ampere flowing around through 2,000 turns of wire. Again it consumes a fixed amperage and a fixed voltage, consequently a known wattage or energy, to affect the ampere turns in the primary coil necessary to magnetize the core of a converter, and if the efficiency of the apparatus is perfect, the energy of the magnetism will be reconverted into electrical energy in the secondary coil, equal in value to that expended in the primary. If, therefore, ½ an ampere at 2,000 volts goes into the primary, an equal energy, such as 40 amperes at 50 volts, may be drawn from the secondary. It is now apparent, I hope, that alternating systems owe their ability to operate over long distances, and with small conductors, to the fact that the electric energy driven from their stations to the point of consumption consists of small amperages (necessitating but small conductors) and high voltage. Then the converter transforms this energy into a nearly equal value, but of low voltage and of correspondingly increased amperage.

There is another interesting feature in converters which is a very important factor in the economical operation of alternating systems. It is the phenomenon or fact, whichever you like, called counter electro motive force. To illustrate. A constant potential dynamo and a motor are in reality one and the same machine. Apply power to it and electricity is produced, or apply electricity to it and power is produced, either or both resulting from the rotation of the armature within a magnetic field. When the machine is running as a motor then the conditions are virtually the same as when it is being driven as a dynamo, for the armature is being revolved between magnetic fields as is a dynamo, and a current or electrical potential must therefore be generated within it. This potential, however, is in polarity opposing or counter to that of the source of electricity which drives the machine as a motor, which leads to the calling the opposing potential "counter electro motive force." A constant potential motor in running without load generates a counter electro motive force nearly equal to the voltage of the supply current, and as a result of this nearly balanced counter electric pressure, but very little current will go into the motor. If, however, a load be thrown upon the motor checking its speed, the counter electro motive force is lowered as the speed slackens, the counter pressure being relieved to a certain extent, and the motor takes more current. Throw off the load, and the armature speed increases, the counter electro motive force raises, and again the motor takes but little current. Such motors are, therefore, self-regulating—that is, they take current or amperage almost in direct proportion to the work they perform; hence their economy in operation is great.

If a clear understanding of this is had, it will not be difficult to fathom the almost identical action that takes place in the converter. There an impulse of current circulates in the primary coil, magnetizing the core, which in turn induces a current in the secondary coil, and this secondary current is of a polarity opposite to the succeeding alternation of current which energizes the core. Inasmuch as the primary coil surrounds the core just as the secondary one does, it is plain that an electric pressure must also be induced in the primary coil synchronously with and in the same direction as that induced in the secondary coil. This is precisely what does occur, and here we have the counter electro motive force in converters. While no current is drawn from the secondary the polarity of the counter electro motive force in the primary nearly opposes the polarity of the succeeding alternating impulse that magnetizes the core. Hence but little or practically no current passes into the primary, but when the current is drawn from the secondary the magnetism of the core, having work to do, does not respond to the rapid alternation so promptly, or, technically speaking, "lags," which results in a tardy counter electro motive force, and consequently greater consumption of current in the primary. Converters, then, like motors, consume current in close proportion to the work they perform.

With the exception of the transformation of electric energy from high to low potentials through the converter, the methods of operating alternating systems are the same as practiced in constant potential systems. The current taken from the secondary coils of the transformer is distributed throughout the premises to be lighted just as in the ordinary incandescent

* A paper read before the Fire Underwriters' Association of the Pacific Coast

system, yet the hazards of the systems are not identical in every detail. Crossed circuits or contact with bell wires, or with gas pipes, are as dangerous in one system as in the other. With alternating circuits, however, little or nothing is to be feared from the disastrous electrolytic action, or, more properly speaking, from the electro deposition that invariably occurs when any form of moisture forms an electrical connection between any two continuous current conductors of opposite polarity. As has been previously explained, the wearing away of one conductor by electrolytic action is a most prolific source of trouble. Why this hazard cannot exist in alternating work will be plain when it is remembered that to deposit metal the current must flow in one direction only; hence, with an alternating current the metal deposited from a positive impulse will be sent back to the anodal wire by the succeeding negative impulse, and so on. No real deposition will, therefore, occur, though electrolysis proper, or the liberation of gases, is possible.

To offset this hazard, which is inherent only in the use of poorly constructed continuous current systems, the alternating system has a hazard, distinctively its own. No matter what the make, converters will some time burn out, either from improper insulation, careless handling, or overload, and when a converter burns out, fire may be caused by any one of several causes. First, the high potential primary current may get over into the secondary coils and be distributed thence over the interior wiring designed to carry, not a pressure of 1,000 or 2,000 volts, but 50 or 100 volts. The hazard of such an occurrence is apparent. Some forms of converters are saturated with inflammable compounds used to effect insulation. If such a converter burns, the insulating compounds will sometimes melt and run down like boiling tar over whatever is beneath, and boiling tar and electrical fireworks would make a combination not at all agreeable to the fire underwriter. All that is apparent in nine out of ten converter burnouts is simply a lively humming and the appearance of considerable smoke. Converters are invariably placed in iron cases, and fire within them could do no external damage other than that due to smoke; indeed, in some localities the placing of converters in insured buildings is prohibited, principally for the reason that, should they burn out, the presence of so much smoke might lead to the calling out of the fire department and a consequent water damage, but this is an idea in which I cannot concur. These are the differences in the hazards of the two systems, and comparative consideration of them both leads to the belief that despite the hue and cry about high voltages, one system is just about the same as the other.

The public is frequently told by those who should, if they do not, know better, that an alternating current cannot maintain an arc, and that the system is consequently free from one of the hazards of the continuous current circuits. If this statement is true, how is it that arc lamps are burned on alternating circuits? It is certain, however, that accidental alternating arcs are very uncertain in their action. Sometimes they will draw out nearly as long as continuous current arcs of equal voltage; then the next instant the arc may almost refuse to form; in fact, it acts as though the arc depended for its length upon the position or phase of alternation at the exact instant of break in the arc producing contact.

An analysis of an alternating impulse shows that it begins at a zero pressure and rises to the full potential of the machine, say 2,000 volts; then the potential falls gradually back to zero again, whence it continues falling to a potential of 2,000 volts below zero, we might say, from which point it rises to zero and continues another cycle. In a 2,000 volt alternating current there is, therefore, a maximum variation of 4,000 volts between the highest potential and the lowest potential, and there is, moreover, two points in each alternation at which the potential is nil, or zero. These points may occur within less than the one one-thousandth part of a second, yet that is a material space of time when reckoned by electricity. As stated, arcs drawn from breaks in alternating circuits are so erratic in their action that they appear to depend upon the phase or condition of the current at the exact moment of break.

Sometimes long arcs may be drawn out, possibly because the cycle at the instant of break is at a maximum potential; sometimes, though seldom, little or almost no arc at all will be drawn, possibly for the reason that the current was broken at the exact moment when it was at a zero potential. These are things that cannot be predetermined, yet, everything considered, it is true that alternating arcs are not as formidable or as vicious as those drawn out from continuous currents of equally high voltages.

The remarkable flexibility of electric energy, when converted from one form to another by means of the alternating current transformer, has led to the achievement of numerous results hitherto considered impracticable if not impossible. The perfection of the art of electric welding is due to alternating currents, as are also certain forms of electric heaters and some new and novel electric motors especially adapted to transmitting power over long distances. In fact, it is believed by many that the greatest advances made in electricity during the coming decade will be in the direction of alternating systems. As the use of these, like all other applications of electricity, is becoming more and more familiar to the public, the belief is slowly but surely, though perhaps unconsciously, being accepted that the hazards attending the use of all forms of properly installed methods of electric lighting or power are greatly exaggerated. In the present state of the science, where a rigid enforcement of insurance or municipal requirements, supplemented by vigorous inspection, results in the observance of safety laws, it may be truly said, even by the most conservative, the fire hazard of electric lighting is more imaginary than otherwise. The tendency of the period in electrical development is toward the use of alternating currents at higher and higher potentials, yet the safety devices designed to control these excessive voltages prove absolute in their offices, so that it is safe to predict that neither the fire underwriters nor the public will find a materially increased hazard in their use.

A WEEPING willow at Riverhead, L. I., is over a century old, and measures 21 feet around and 100 feet across the top.

## SIR GEORGE AIRY.

SIR GEORGE BIDDELL AIRY, K.C.B., F.R.S., the late astronomer royal, who died January 2, 1892, was born at Alnwick, in Northumberland, in 1801. From school he passed, at the age of eighteen, to Trinity College, Cambridge, where he graduated as senior wrangler in the year 1823. In 1824 Mr. Airy, as he then was, was elected a fellow of his college, becoming, two years later, Lucasian professor of mathematics at Cambridge. From this he proceeded to the Plumian professorship of astronomy, to which office he was elected in 1828. Attached to the post was the direction of the observatory, and here Mr. Airy's genius as an observer and scientific astronomer had full scope. His love and talent for mathematical calculations had led him to the study of astronomy from an early age. Professor Airy held charge of the Cambridge Observatory for eight years, and then was appointed astronomer royal at Greenwich in succession to Mr. Pond. The great work of his life now began, a work that lasted more than forty years. First setting to work to renew the equipment and reform the administration and methods of the Greenwich Observatory, he then took in hand the immense task of the reduction of the Greenwich lunar and planetary observations since 1750. The task took Mr. Airy until 1848 to complete. But the astronomer royal had other work to perform as well. In 1842 he visited Turin to observe the solar eclipse; in 1851 he visited Sweden for the same purpose; and in 1860 he organized the eclipse expedition to Spain. He also had charge of the arduous preparations for the equipment of the British expedition for observing the transit of Venus in 1874. The late astronomer royal did much useful work outside the observatory—in his experiments on the deviation of the compass in iron-built ships; his researches on the subject of the density of the earth; and his services in fixing the breadth of railways. He was, further, chairman of the commission on the new standards of length and weight after the fire which destroyed the Houses of Parliament in 1834, and also conducted the astronomical observations preparatory to the delimitation of the boundary between Canada and the United States. In 1871 Mr. Airy was made a C.B., and K.C.B. in 1872. He was president of the Royal Society from 1871 to 1873. Sir George Biddell Airy was medalist of the French Institute, of the Royal Society (twice), and also of the Institution of Civil Engineers. From Oxford, Cambridge, and Edinburgh he received honorary degrees, and was an honorary member of many scientific societies both in England and abroad. Sir George Biddell Airy retired from his post at Greenwich in 1881 with a pension of £1,100, after forty-five years' service. His "Popular Astronomy" is well known. Besides this, he was the author of treatises on "Errors of Observation," on "Sound," and on "Magnetism," and of papers in the encyclopedias on "Gravitation," "Trigonometry," the "Figure of the Earth," and "Tides and Waves."—*Daily Graphic.*

SIR GEORGE AIRY.

## TWO METEORIC FINDS.

THE *American Journal* for January contains the following by A. E. Foote:

A physician residing near the Maryland line of Pennsylvania recently brought to me an iron mass to learn if it was meteoric, and this it has proved to be. It was discovered in Garrett Co., Md., about twelve miles from the post office of Lonaconing, not far from the boundary. It was plowed up about three or four years ago by a boy in a field. According to an analysis by Dr. Koenig, it contains over 11 per cent. of nickel and cobalt, the proportion of cobalt being unusually high.

It is one of the best octahedral etching irons known, being even more characteristic than the most of those that have been used for printing directly on paper. Besides the striking reticulated octahedral structure, it shows a large number of secondary lines regularly disposed with reference to the principal markings. These I believe to be similar to those described by Prof. J. Lawrence Smith, in a Wisconsin meteorite, under the name of Laphamite markings. The original weight was 45 oz., but it has been reduced by analysis, cutting, polishing, etc., to 36½ oz. The locality is especially interesting, since this is one of the very few discovered in the Middle or Eastern States.

The following is Prof. J. Lawrence Smith's description of the Laphamite markings on the Wisconsin iron, and it applies to the Garrett County siderite, except that the bright figures are the ones that show the secondary marking.

"The Widmanstattian figures are, *a*, bright metallic, with convex ends and sides; *bc*, of a darker color, are the other markings, usually smaller, and with the sides and ends concave. The material of which these dark figures are composed seems to have enveloped the lighter colored portion, which serves to make the dark lines so beautifully conspicuous. A good pocket glass will show that the dark figures are striated, with lines at right angles to the bounding surfaces. When the figure is nearly square the lines extend from each of the four sides, but when much elongated, as at *c*, they are parallel with the longer sides. Often these lines do not reach the middle of the figure, where only a confused crystallization can be detected. In the interior of the elongated figures the lines are quite irregular, often running together and showing a striking resemblance to woody fiber. The nature of these markings may be easily understood. They indicate the axes of minute columnar crystals, which tend to assume a position at right angles to the surface on cooling."

Also the following by George Frederick Kunz and Ernest Weinschenk, Ph.D.:

On Wednesday, June 25, 1890, at 12:55 central time, a roaring, rumbling sound was heard within a radius of one hundred miles around Washington, Washington Co., Kansas, and many observers noted a meteorite traveling from south to north, which in its course left a double trail of smoke. The sun at the time was shining brightly, and hence no light was seen. The explosion was likened by various observers to a bolt of lightning, the bursting of the boiler of an engine, or the report of a distant cannon. The largest portion of the meteorite, weighing 180 lb., fell on the farm of Mr. W. H. January, who was greatly alarmed, as it struck very near him while he was under his wagon repairing it. This piece penetrated the hard shaly earth to a depth of four feet. Forty pounds of it were broken off and distributed before it was placed on exhibition, after which it was sold and resold several times, and now belongs to Prof. Henry A. Ward, of Rochester. Its dimensions now are 16½×16½×8 in.; weight 136 lb. A distinct mass weighing nine pounds, now in the possession of George F. Kunz, was found on the farm of John Windhurst; and it is evidently this piece which made the second trail of smoke.

The sound was noticed throughout a number of counties, both in Kansas and Nebraska, as a thunderous roar, which at Clifton, twenty-five miles from the point of fall, was heard above the noise of a passing railroad train. The meteorite was seen over a much wider area even than its sound covered. Reports of observers are given from many places, ranging from Beatrice, Nebraska, 40 miles northeast of the point of fall, to Cedar Junction, Kansas, 130 miles southeast, and Halstead, Kansas, an equal distance south by west. To those north of the point of fall, it appeared as a brilliant object moving southward, while to observers south of that point its motion seemed northward. As Prof. F. H. Snow, who gives a full account of the circumstances attending the fall, remarks, these facts indicate that its descent must have been not far from vertical, as is also shown by the nearly perpendicular hole, about four feet deep, which it made in the earth.

The actual fall was witnessed by Mr. January, as he came out from under his wagon alarmed by the extraordinary noise, and also by Miss Guild, a teacher in the Washington County Normal Institute, who was driving on the neighboring road, a hundred yards distant. Both came to the spot in a very few minutes; and Mr. January began promptly to dig for the object, and with the aid of neighbors reached its upper surface in an hour. But so firmly had it embedded itself in the shaly clay, that it was three hours before it was removed. When reached it was not hot. It had cracked into two portions, the smaller of which was the forty pound mass broken up and carried away by the people of the neighborhood.

At the moment of its fall, the earth was thrown upward and outward for a distance of eight to ten yards or more.

The following analysis was made by Mr. L. G. Eakins through the courtesy of Prof. F. W. Clarke, chief chemist of the U. S. National Museum, Washington, D. C.

| Approximate composition of the mass. | | Analysis of the iron. | |
|---|---|---|---|
| Nickeliferous iron | 7·7 | Fe | 86·76 |
| Troilite | 5·0 | Ni | 12·18 |
| Siliceous part soluble in HCl. | 46·0 | Co | 0·83 |
| " " insoluble " " | 41·5 | | |
| | 100·2 | | 99·77 |

Analysis of the siliceous part from which all magnetic material had been extracted.

| Soluble in HCl. | | | Insoluble in HCl. | |
|---|---|---|---|---|
| [1] | [2] | | [3] | [4] |
| $SiO_2$ 19·15 | 38·50 | $SiO_2$ | 24·29 | 53·80 |
| FeO 16·15 | 23·54 | $Cr_2O_3$ | 0·64 | 1·41 |
| NiO 0·34 | 0·69 | $Al_2O_3$ | 1·95 | 4·32 |
| CoO tr. | tr. | FeO | 5·41 | 11·98 |
| MnO 0·17 | 0·34 | MnO | tr. | tr. |
| CaO 0·06 | 0·12 | CaO | 1·84 | 4·08 |
| MgO 18·31 | 36·81 | MgO | 10·10 | 22·37 |
| S 1·97 | | $K_2O$ | 0·12 | 0·27 |
| | | $Na_2O$ | 0·80 | 1·77 |
| 56·15 | 100·00 | | 45·15 | 100·00 |

Analysis No. 1 is the direct analysis of the portion soluble in HCl. Analysis No. 2 is calculated to equal 100. Analysis No. 3 the composition of the insoluble part. Analysis No. 4 calculated to equal 100.

The nickel iron of this specimen shows, as is generally the case in stony meteorites, a higher percentage of nickel and cobalt than is usual in meteoric irons. The constituent in this stone which was dissolved by hydrochloric acid is shown by that fact to be olivine, in which the proportions of magnesia and iron are as three to one. The crust on this meteoric stone is black and dull, frequently over 1 mm. in thickness. Microscopically the Washington meteorite resembles a doleritic lava, of dark gray color and splintery fracture, with white radiated chondri which protrude from the ground mass. The specimens also contain druses lined with crystals of sulphide of iron, the faces of which are

rounded and present the appearance of having flowed through fusion, thereby rendering it impossible to measure the angles. No analysis of this material was made, although from the total lack of oxidation it might have promised good results.

Nickeliferous iron, which in the fracture is only slightly visible, becomes conspicuous on a polished surface, showing that it is present in many grains, some exceedingly minute, others up to 4 mm. in diameter. In one instance a vein 10 mm. long and 1 mm. wide penetrated the mass, and on the surface of a polished section appeared bright serpent-like veins. The crust of the meteorite is black, hard, and uneven, and the surfaces, 0·8 mm. large, are dull and often of bead-like form. Under the microscope, the porphyritic character of this meteorite is readily recognized; radiated and broken chondri and crystals of various minerals make up the microfelsitic ground mass.

All these are entirely enveloped in an opaque, evidently glassy magma, the dark shade of which gives the color to the whole. This dissolves in cold HCl, imparting a yellow tint to the acid. Heating to redness does not destroy the color, which fact surely precludes the idea of its being due to the presence of any organic matter. Prominent are crystals and fractured masses of olivine, which feature is of rather rare occurrence. This olivine is rich in orientated opaque inclusions, and has also a distinct cleavage, which is seldom observed in olivine. The optical character was perhaps disturbed through the rapidity of its crystallization.

Distorted undulation is common. Rhombic pyroxene is readily identified, frequently with a fibrous cleavage and monosymmetric augite; also the monticellite-like silicate described by Tschermak. The Washington County meteorite belongs to the black chondrites and has the greatest resemblance to the meteorite of Sevenkof. It is undoubtedly not a polygenius conglomerate, but was rapidly formed out of the fluid glassy magma.

The thanks of the describers are due to Prof. F. W. Clarke and Mr. L. G. Eakins of the U. S. Geological Survey for the analysis, to Prof. Henry A. Ward for facts concerning his mass, and to Mr. Daniel Scheckler, of Washington, Kansas, for obtaining one mass and information attending the fall.

## ARTIFICIAL FERTILIZATION.

IN a recent report of the Agricultural Experiment Station, of New York, there is some interesting information upon artificial fertilization. Reference is particularly made to the necessity of phosphoric acid in the soil, and although it is pointed out that almost all kinds of soil contain phosphoric acid, it is generally in a form in which it is not easily removed by plants. In soils which are known to be rich in phosphoric acid the quantity which the roots can take up daily is limited, so much so that it can only suffice to produce an average crop in a good season. As good seasons are, however, comparatively rare, the supply is not sufficient for the farmer's use. The writer points out that the plants may stop growing when there is no rain for a fortnight, simply because they are unable to absorb the phosphoric acid which is soluble; but when rain comes they not only take up what is present in the soil, but are ready for more. If there is no more, so much the worse for the crop; but if it has been provided by a dressing of artificial fertilizer, then, if other necessary plant foods are present in requisite quantities and are equally available, the plant can go ahead, and an abundant yield is the result. Wagner says that abundant phosphoric acid should always be in the ground, because plants are always ready to feed upon it after rain. Hence the farmer should be liberal with it, inasmuch as its presence is indispensable for any large crop. No fear need be entertained, as in the case of nitrate of soda, that serious loss may occur if it is not taken up by the growing crop, because if it is not removed by the one for which it was intended, it will still be available for the crops which succeed it. Professor Stutzer, a well known German scientist, says that 200 lb. of phosphoric acid is a low dressing per acre, 350 lb. a medium dressing, and 550 lb. a high dressing. Referring to nitrate of soda in the same way, he suggests that 90 lb. is low, 180 medium, and 350 high. At the present price of nitrate there are not many, we imagine, who will venture to expend money upon it at this high suggested rate, although doubtless in many cases the money would be returned with interest. The potash dressing in the form of kainit is given by the same author at 200, 350, and 540 lb. respectively. He makes a suggestion which is worthy of notice, and it is to the effect that for barley, potash may be increased as a dressing and nitrogen reduced. Although all soils contain potash, there are certain crops, such as the leguminous crops, which are greedy for it, and although all grain crops are dominated—as it is put by Ville—by nitrogen, Stutzer's suggestion is worthy of recollection. He also says—and this is a pregnant suggestion—that phosphoric acid may be increased upon humid, heavy soils and nitrogen reduced, while upon dry, light, warm soils phosphoric acid may be reduced and nitrogen increased. The last remark is new to us, and probably to many others.

No reason is given to account for it, but practitioners will probably observe for themselves. Although it may not coincide with the views which some entertain, the author is not a man who can be disposed of offhand. He adds that if a soil is rich in nitrogen, or if the preceding crop was, as Wagner calls it, a nitrogen gatherer, such as beans or clover, the nitrogen should be reduced. This is advice which is practically accepted wherever the science of manuring is understood. With regard to the question of the utilization of the nitrogen of the air by leguminous plants, or, as they have been called, nitrogen gatherers, Dr. Gilbert, who, in conjunction with Sir John Lawes, has made important experiments, suggests that the alternative explanations are—first, that the plant is enabled under the conditions of the symbiosis to fix the free nitrogen of the atmosphere by its leaves; secondly, that the organisms become distributed in the soil, and there fix free nitrogen, the resulting nitrogenous compounds becoming available as a source of nitrogen to the roots of the higher plants; thirdly, that free nitrogen is fixed in the course of the development of the organisms within the nodules, and that the resulting nitrogenous compounds are absorbed and utilized by the plant. Dr. Gilbert believes that the balance of evidence is in favor of the third explanation. At the same time it will be recognized, at all events by those who have followed up the subject, that comparatively little is known with reference to the organism, parasite, or microbe, to use another popular term, which appears to be the means of infecting the plant in some way with nitrogen.

## PHILADELPHUSES OR MOCK ORANGES.

A VERY beautiful class of flowering shrubs is that formed by the Philadelphuses or mock oranges, and with the gradual rise in the love for flowering trees and shrubs in general, the genus has not been overlooked. It is not large but extends over a wide area, embracing Europe, North America, and Asia, the various types having beauty of both habit and flowers, possessing also a sweet fragrance that becomes almost too powerful when a large specimen is in full bloom. It is pleasant to walk into an old garden and discover a fine Philadelphus, as, when in health, it is a tree of characteristic beauty, leafy and with flowers that bear no little resemblance to those of the orange, this likeness and the fragrance giving rise to the popular name of mock orange.

The common species is P. coronarius, called also the garland Philadelphus, and grows about twelve feet in height, the shoots slender, and bearing in loose clusters pure white flowers in the months of May and June. Thanks to its adaptability for culture in many places, it is a shrub universally grown, from Lisbon to St. Petersburg, and in the Russian capital this mock orange proves one of the only things in the shrub way that can be used. For many years it has adorned English gardens, and was one of the shrubs mentioned by Gerard, who, in his garden "in the suburb of Holborne," had specimens of it "in verie great plentie." One reason of its abundance is its easy culture, having no great dislike to any soil or position. I have known the shrub thrive in ground scarcely fit for the coltsfoot, and in a position where it was impossible for the shoots to spread out in their own characteristic fashion. The mock orange in the majority of gardens serves as an illustration of how not to do it, usually forming part of the crowded shrubbery, where the various things are prevented from disclosing their true beauty through want of proper accommodation. But apart from other shrubs, so that its characteristic features can be properly developed, the Philadelphus is a graceful shrub, beautiful in early summer for its wealth of flowers, and the whole year through for its graceful shoots. There are several ways of propagating them, one being by division of the root, which consists in lifting the plants and dividing them, another by layers. It is also easy to increase them by suckers or cuttings. The remark as to the flowers of the several kinds having a sweet fragrance must be modified, as all are not in possession of this delightful trait.

P. inodorus, for instance, has flowers that are not blessed with the precious virtue of sweet scent; hence the name. It is a native of South Carolina, and found upon the river banks, from whence it was introduced into England in the year 1738. It is practically a variety of P. coronarius, more rambling, however, in habit, dwarfer and less hardy. P. laxus, so named by reason of its loose growth, is a native of North America, and introduced about the year 1830, the growth being rambling, and the height of the shrub three feet or four feet. A bright jewel among mock oranges is P. grandiflorus, also a native of North America, and a familiar species. It was introduced in the year 1811, and has scentless flowers of good size, and creating a brave show of white.

P. gordonianus may also receive mention for its beauty. It is not advisable to use many variegated shrubs in the garden, as they are apt, unless used with extreme care, to create a spotty effect by reason of the blotchy nature of the leafage. A few years back, when conifers were enjoying their reign, variegated varieties were used recklessly, and the result was undesirable effects and poor growth, as variegated plants are not, as a rule, robust in constitution. Of Philadelphuses, there are two distinct variegated forms, one named aureo-variegatus, in which the coloring is golden, and the other argenteo-variegatus, that displays a silvery tone, as suggested by the name. One or two examples in a garden, however, will be sufficient, and prove bright features through the summer season.

SMALL LEAVED MOCK ORANGE, PHILADELPHUS MICROPHYLLUS. (FLOWERS WHITE.)

When we pass away from the taller types, we come to the dwarfer kinds, represented by such forms as P. microphyllus and P. hybridus lemoinei. The older of the two is P. microphyllus, which was introduced from Colorado a few years ago, and has now become well established in English gardens. We are indebted to Prof. C. S. Sargent for its introduction to England, but, apart from Colorado, it has a home also in various parts of Utah and South Texas. It is quite dwarf, a miniature bush, rising about two feet in height, and spreading about in a charming graceful way, as the growth is distinctly wiry and free, creating a dense mass of white when the terminal flowers are fully expanded. It has affinity to P. serpyllifolius, and is a delightful species for filling a distinct bed, or giving beauty to the higher parts of the rockery. The accompanying illustration gives an idea of its erect, wiry growth, and profusion of blossom.

Another very beautiful variety is P. hybridus lemoinei, a hybrid, as its name indicates, and this between P. coronarius and P. microphyllus. It partakes more of the character of the last-named parent, and is

a lovely shrub for massing on the outskirts of the lawn, its graceful shoots studded with flowers larger than those of P. microphyllus, spotless white, and almost hiding the leafage. A pretty picture was formed by it in the gardens of Sir Trevor Lawrence, Bart., at Burford Lodge, early last summer, when a plant, about three feet in height, or less, was smothered with flowers, the branches gracefully bent, and almost touching the ground; while the sweet fragrance loaded the air for many yards around. Neither is troublesome to grow, and both deserve the attention of all who delight in hardy flowering shrubs of distinct beauty.—*C., in The Gardeners' Magazine.*

## LAKE TE-ANAU, NEW ZEALAND.

THE country known as New Zealand is in the southern hemisphere, and consists of two large, narrow islands, extending northeast and southwest, between latitude 34 and 48, having an aggregate area of about 100,000 square miles; length, some 750 miles; 45 to 250 miles broad. It is a very mountainous land, having many rivers and lakes; the climate is equable and temperate, the scenery in many parts grand and magnificent. In South Island, among the larger lakes, is that of Te-anau, of which we give an illustration. It conveys some idea of the superb character of New Zealand scenery. The lake has an area of 132 square miles. Our engraving is from the London *Graphic*.

## RELIGION OF SAVAGES.

BEFORE the Anthropological Institute, Dr. Edward B. Taylor, F.R.S., read a paper on the limits of savage religion. In defining the religious systems of the lower races, so as to place them correctly in the history of culture, careful examination is necessary to separate the genuine developments of native theology from the effects of intercourse with civilized foreigners. Especially through missionary influence since 1500, ideas of dualistic and monotheistic deities, and of moral government of the world, have been implanted on native polytheism in various parts of the globe. For instance, as has lately become clear by the inquiries of anthropologists, the world famous Great Spirit of the North American Indians arose from the teachings of the Jesuit missionaries in Canada, early in the seventeenth century. This and analogous names for a Supreme Deity, unknown previously to native belief, have since spread over North America, amalgamating with native doctrines and ceremonial rites into highly interesting but perplexing combinations. The mistaken attribution to barbaric races of theological beliefs really belonging to the cultured world, as well as the development among these races of new religious formations under cultured influence, are due to several causes, which it is the object of this paper to examine: (1) direct adoption from foreign teachers; (2) the exaggeration of genuine native deities of a lower order into a god or devil; (3) the conversion of native words, denoting a whole class of minor spiritual beings, such as ghosts or demons, into individual names, alleged to be those of a Supreme Good Deity or a rival Evil Deity. Detailed criticism of the names and descriptions of such beings in accounts of the religions of native tribes of America and Australasia was adduced, giving in many cases direct proof of the beliefs in question being borrowed or developed under foreign influence and thus strengthening the writer's view that they, and ideas related to them, form no orignal part of the religion of the lower races. The problems involved are of great difficulty, the only hope of their full solution in many cases lying in the researches of anthropologists and philologists minutely acquainted with the culture and languages of the districts; while such researches will require to be carried out without delay, before important evidence, still available, has disappeared.

## THE SOURCES OF OUR RUBBER SUPPLIES.

By I. A. SHERMAN.

THERE are merchantable in New York between thirty and forty different sorts and grades of India rubber, the variations determining the selection by manufacturers in the purchase of stocks. Of course rubber in all its variations is essentially the same, differing somewhat in the same degree as the pumpkin in South Dakota from that in New England—one large and another small, one with little flavor and the other richer in food qualities. The difference between sorts of rubber, however, is due in large measure to the methods employed in gathering the sap. It happens that the natives of the Amazon Valley have always taken pains in the curing of rubber. While climatic conditions in that country may have had their influence upon the character of "Para," the condition in which this rubber is exported has become a prime factor in making it a favorite with manufacturers. On the other hand, some of the African sorts are so full of bark and stones as to make them almost unfit for use. At one time "Assams" were almost unmarketable in New York, the price sinking as low as ten cents per pound, and not wanted at that. One firm, after long experimenting, discovered a chemical solution in which the rubber was washed, the process being that the bark and other impurities absorbed the chemicals, making them so heavy that they separated from the gum and fell to the bottom and away. This company made a fortune in a moderate space of time, but they put up gradually the price of Assams, from the fact of their creating a demand for that sort of rubber, until the profits became comparatively small, when they disposed of the privilege of washing to some leading rubber men who use the process at the present day.

Para rubber is more largely consumed in the United States than any other. It may be noted, also, that the larger share of the rubber exported from Para comes to this country. There are three grades—fine, medium and coarse. Fine Para is the standard by which all other grades are measured; it brings the best price, and probably is more used than any other. Should it become irregular in quality in the operation of curing over the smoke of palm nuts—as when little strips of virgin gum occur in the grain—it is called "medium," and its price is lessened by a cent or two per pound.

The "coarse" is imperfect, being composed of the scrapings and refuse of the fine sorts, and sells for about two-thirds of the price of the better grade. It shrinks considerably, having much water in it, and the importer generally is in a hurry to turn it over to the manufacturer. There are again many variations in Para rubber coming from different localities on the Amazon. This subject is involved in some obscurity, but the best rubber is supposed to be found on the river Purus, a tributary of the Amazon having its source in the Andes. Brazilians, however, are apt to believe that the locality of the best sorts is unknown to Americans, and possibly the Purus may not be the locality.

There comes from Peru, at the sources of the Amazon and its tributaries, a rubber resembling the Nicaragua sheet, and called Caucho. This rubber is very wet and consequently shrinks very much, which is a serious drawback. It is considered a good strong rubber and it is utilized to a considerable extent by the boot and shoe manufacturers.

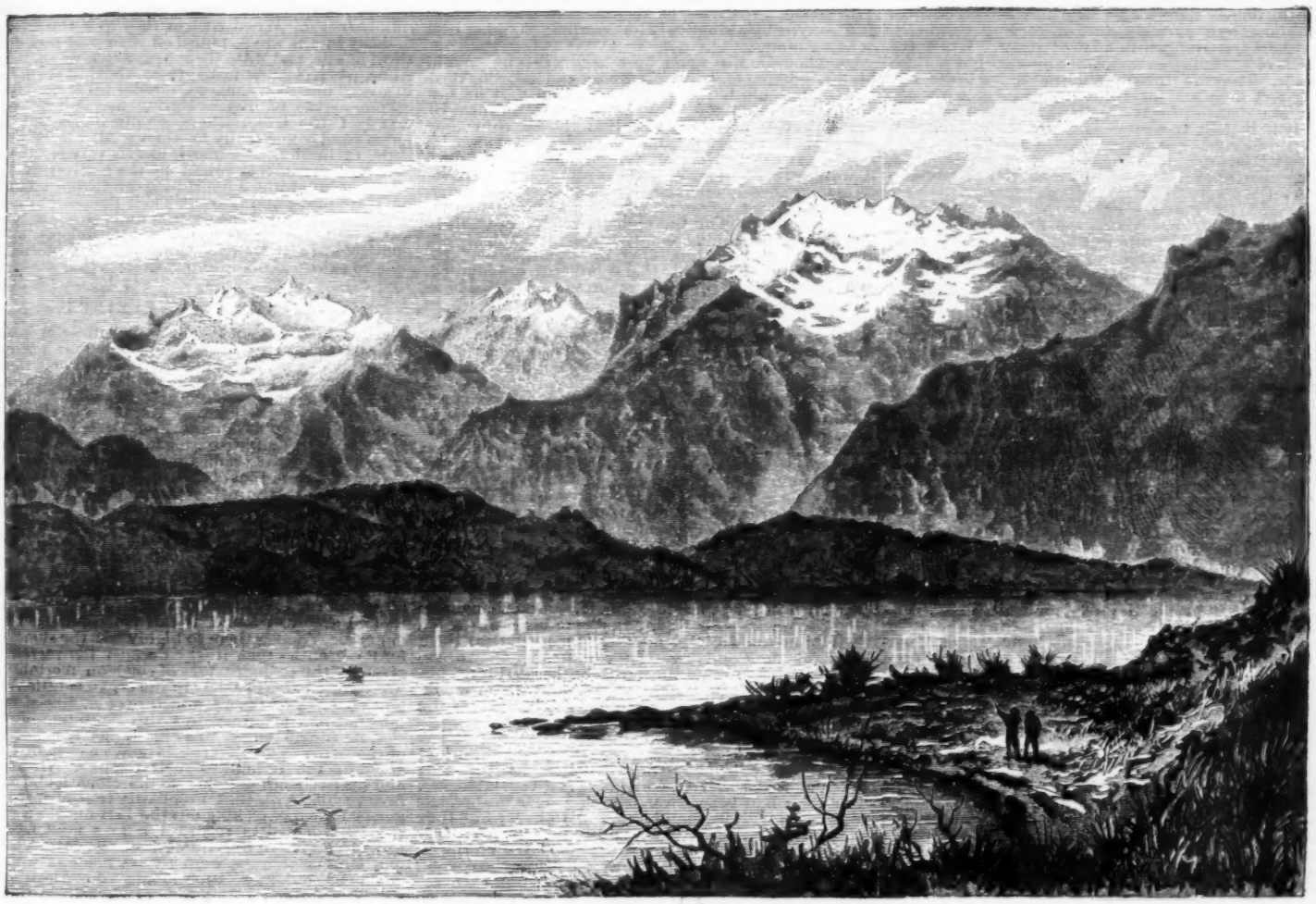
Of Ceara rubber there are three grades, numbered one, two and three respectively. It is called a "mule gum," the significance being that it is neither one thing nor the other, it being so deficient in elasticity as to cause some to argue that it is not rubber. It is used to some extent in the manufacture of mechanical rubber goods, but as it does not vulcanize like ordinary rubber, many firms do not understand the manipulation of it, and it is not very popular. Number one is the finer grade, number two is a mixture of one and two, and number three is very dirty and difficult to use. It consists of reddish brown string-like pieces made into balls or blocks. It is a very dry rubber, its gathering being peculiar. The tree is incised at the beginning of the dry season, and as the gum oozes from the wound it forms on the outside of the bark, to be pulled off at the end of the season. The gathering of this rubber seems to be on the wane, for every year there is an extensive migration of Ceara people to Para, bound for the forests of the Amazon.

From Bahia and Pernambuco, in Brazil, comes a rubber of a different grade from that of Para. It is cured with alum and salt water. The Pernambuco comes in sheets, and is of a yellowish white tinge. That from Bahia is not so good and comes in round balls. The principal objection to it is that it is very damp, entailing a large loss to the importer from shrinkage.

Of Mangabeira rubber there are three grades, very similar to the Bahia and Pernambuco sorts. It is a difficult sort to work, but it is one of the few rubbers that will cure white, and is largely used for tubing, water bottles, and articles of that character. A grade that has a red look is considered superior and sells for five or ten cents per pound higher than the others.

From Central America comes a variety of rubbers, distinctive in name theoretically, but owing to the lines of transportation centering at Greytown, and the transshipment at that point to New York, there is much confusion, one sort often getting substituted for another. The Pacific Mail steamers gather also different varieties at Panama with the same confusion. That which comes from Nicaragua is called Nicaragua "sheet" and "scrap." The latter comes in pieces about 2½ feet long, weighing from ten to forty pounds. In the gathering of rubber in the forests, around the cuts in the tree a residuum is left, which is given to the men as a perquisite, and this forms "scrap." As in the peculiar mode of gathering it is very dry, there is little loss in shrinkage, and this quality makes it a favorite with manufacturers. It contains some bark, but not so much as in the "sheet." The sheet, after it is milled and washed, is the same rubber as the "scrap." Both are cured by the use of a vine from which a soapy substance is formed.

There is another grade which comes from Central America, containing a considerable amount of ashes, due to its being smoked over the latter. It comes in



TE-ANAU LAKE, NEW ZEALAND.

thin sheets ⅛ to ¾ inch thick. It is a dry rubber, there not being so much loss in shrinkage, but it is not so firm as the other grades, and it is difficult to work. There also comes from Central American ports a rubber which is chiefly grown in New Granada, and is called "Carthagena strip." It is from 1½ to 2 inches thick, and there is a great deal of sand and dirt in it. It is a black, tough rubber.

Honduras furnishes a great deal of rubber of the Tuno sort, which is found in many other sections of Central America. Guatemala ranks low in the American varieties, containing a resinous substance which gives it a tarry appearance. It comes in sheets pressed together. There is a rubber which comes from Angostura, as good as Para. When cut it is found to contain little spots of white as large as a pea. Tuxpan, Mexico, once sent a fine grade of strip rubber, but as the trees have been destroyed by cutting them down instead of tapping for rubber, the imports from there are now very small. The rubber is gathered by scraping from the bark.

Guayaquil comes in large flakes or lumps of a whitish color in the best sorts, the inferior sorts being porous and exuding a black liquid which stains the knife and hands. As in a great many "Centrals," the name is often confounded with the sorts.

Esmeralda comes from Guiana, is a strip rubber, and is also made into "sausages." Some brokers are of the opinion that very little of the real Esmeralda finds its way to America, it being almost indistinguishable from other grades. It brings a high price. Certainly little of it finds its way to Europe, brokers not quoting it there. A great deal of the rubber gathered in Colombia finds its way to the Amazon and Para.

In rubber from Asia the Assams probably take the lead, and are rated above coarse Para in price. They come in oblong slabs with a long fiber of two or three feet, about half as wide, and of varying thickness. The slabs are wrapped in plaited straw. When cut they have a marbleized appearance, somewhat pinkish in color. They are three or four grades, the lower ones being very dirty and all of them requiring much washing. The demand for the higher grades is very large, and it is bought in a great measure under contract. Still considerable quantities find a way to America by way of Hamburg and London. These grades are a strong resistant rubber and find their way chiefly into mechanical goods.

There are two grades of rubber coming from Borneo. The rubber from that source was first called a gutta, on account of its geographical location, but this error was a palpable one and soon corrected. It is a white, soft, porous or spongy rubber, the pores being filled with salt water or whey. This is caused by using salt to coagulate it, the outside of the ball, in which shape it comes, being acted upon first, which makes little cells in the interior, filled with salt and water. As this rubber becomes old it changes in color to a dull pink or red, and the water evaporating leaves a saline incrustation in the cells. The better grade is a fair rubber, but the second grade is often when cut almost as soft as putty and practically worthless. The shrinkage in both grades is very large—from 25 to 50 per cent. It is used mostly for mechanical preparations, and to some extent in the manufacture of hard rubber goods.

Of Africans there are many varieties. The favorite sorts comes from Madagascar. The pinky sort comes in the shape of round balls, weighing 1½ to 4 pounds. It is black on the outside, natural from exposure to the air, but when first cut it has on the inside a pinkish white look, and is susceptible of a fine polish, which makes it a favorite with hard rubber men. It is not so strong, however, as fine Para. There is always a good demand for it, and it is rarely found in store, being sold "to arrive." This sort comes from Tamative. There are two or three variations in quality of Madagascars, but the grade called "black" comes from Majunga, is exported in small balls and has a dark color when cut. This latter grade is used to some extent by mechanical goods men and is worth about ten cents less per pound than the pink, which latter ranks next to Para.

From the west coast of Africa there are many varieties, the best coming in the shape called "thimbles," which are square pieces, one inch each way. The rubber is very dry, and is in good demand by mechanical goods manufacturers. It is a very strong rubber, and naturally has little shrinkage. Tongues are shaped as their names indicate. There is considerable shrinkage, but it is a very good rubber. There is also a small ball rubber, about 1¼ inches in diameter. It cuts white and is fairly firm.

Congo ball is made from small strips of rubber and rolled into balls, from 1 to 2½ inches in diameter. It is a firm and very elastic rubber, but there is more or less bark in it, and as manufacturers do not always have proper machinery to exclude it, they do not buy readily.

Sierra Leone comes in balls three to four inches in diameter and is a very fair grade of rubber. It has a considerable demand from boot and shoe and mechanical goods men. Like all West coast rubbers, it reaches us by way of Hamburg or Liverpool.

The finer grade of Mozambique is called "white ball." It resembles Congo ball in appearance and comes in about the same shape. The "red ball" is mixed with a reddish bark and gets its name for that reason. Oftentimes both varieties of "ball" will be found filled in the center with bark. The rubber is then called "unripe Mozambique" and sells for ten cents less per pound.

"Flake" is used very extensively as a friction rubber in mechanical goods—as in hose, where duck is used. It is a soft rubber and cannot be used on hot rolls, as it would stick badly and also run in an annoying manner. It is compared to molasses when it starts off on such a trip, consequently it is used only on cold rolls. For hose, and in cases where cloth is used, it is a very useful rubber.

From Liberia comes a lump rubber, which is harder than "flake." There are three rivers in Liberia from which rubber is gathered, but it is all assembled at the common mouth and the grades are not kept separately, making a class of rubber which is very variable, and therefore disliked by manufacturers.

There is on the whole a growing tendency toward the use of Africans, and in this is a true check on the price of Para. In Centrals there seems to be a falling off in the production consequent upon a scarcity of labor, which has been from time to time drawn into internal enterprises. In Europe the stocks of Africans are always larger than of Para, and a steady growth is very noticeable.—*India Rubber World.*

## LOCUSTS.

By S. L. CLAYES.

ALL our lives we have heard of the likeness which the locust hordes bear to an immense army, advancing with a force so overwhelming as to defy resistance. We have been familiar with the dread but sublime description of their coming given by the prophet Joel. We have even had some experience—though happily slight—of their ravages in our own country. But however vivid may have been the descriptions we have read or the tales to which we have listened, it is only by the added aid of a powerful imagination that we of the Western world are enabled to form any just idea of what a swarm of locusts really means to the nations of the East.

Dr. William Thomson, in his account of one of their incursions into Syria, tells that early in the season a detachment of winged locusts passed over the land, leaving behind myriads of their eggs, which lay glued together in small lumps everywhere over the fields, plains, and deserts. This flying squadron soon disappeared, but in less than two months the eggs began to hatch, and, apparently, the whole surface of the earth awakened into life. Each grain of sand seemed to have become a living, sentient thing. Presently this seething mass of nearly indistinguishable particles developed until it could be seen that it was made up of the tiniest imaginable grasshoppers. The little creatures entered promptly upon their life task of destruction, all moving as vigorously in one direction as if swayed by a single will—a crawling, jumping host of living atoms.

Dr. Thomson was upon horseback when he caught his first glimpse of an extraordinary and puzzling spectacle. He could hardly persuade himself that he saw aright, but surely the whole surface of a hill near by was agitated—moving; more than this—a thin layer seemed to be peeling off and rolling down its sides. It looked like quicksilver; no, too thick for quicksilver—it was more like mortar. What could it be? His interest was greatly excited; so was that of his horse, but while he was eager to approach and examine, the horse was strongly of the opinion that it was well to leave the strange thing as far as possible behind them. Rebellion followed; but, fired by scientific zeal, the doctor left the animal only half conquered, dismounted, and came close. He found his mortar was a living mass of infant locusts—wingless, even too young to leap—that had started rolling down hill for some cause best known to themselves. Perhaps it was only from accident, but who can say what access of baby terror might have swept over them at the heavy tread of the approaching horse.

Some years later Dr. Thomson was privileged to form a more intimate acquaintance with these small imps of destruction, this time grown to their full size, though wingless. He was living upon Mount Lebanon when the locusts were reported to be coming toward the mountain in force. The people put forth every effort to stay their progress, but without success; and soon the whole surface of the earth grew black with the onmoving of their steady ranks. They scaled the rocks, they clambered over walls, hedges, ditches; whatever came they surmounted, never turning aside for any obstacles—not even for the houses—not even for the palace of the Emir—they went straight up over everything and down on the other side. Dr. Thomson thought he might compass, perhaps, the saving of his garden. To this end he hired a large number of men and set them on guard night and day. They built fires, they drove the locusts off, beating them with bushes and branches of trees; but, though many were killed, others so interminably followed in their wake that at length the men fairly succumbed and gave up the battle.

This army was four days only in possession of the land, but when they left it was as if the mountain had been swept by the besom of destruction—as if a great fire had raged over it, consuming all vegetable life. The vines had been covered with young grapes, the trees laden with figs, mulberries, and olives; but they were now barer than ours in midwinter, for even their bark—bitter and hard as it was—had been stripped from them and devoured. The land, before the coming of the locusts, was green as an emerald; now even the gardens were but beds of sand. In the fields not an inch of pasture was spared, not a stalk of corn, not a blade of grass. The flocks and herds were left absolutely without food. Even this was not all. It was soon found that they had eaten up everything made of silk, wool, linen, or leather that they had come upon in their path.

Mohammed endows the locust with speech and makes him say: "We are the army of the great God, we produce ninety-nine eggs, if the hundred were complete we should consume the whole earth and all that is in it."

The Arabs declare that the locust has stolen a part from every bird and beast, taking its body from the scorpion, tail from the dragon, legs from the stork, wings from the eagle, head from the horse, eye from the elephant, neck from the bull, and breast from the lion. Yet it is far from being an ugly creature to look upon. It is about two and a half inches in length, of a pale brown color, the elytra being spotted with darker brown or black. The legs are brown with alternate bands of black and yellow; the hind legs are very large and strong, and are powerful for leaping. The thorax is covered with fine down, and the wings—which are often tinted with iridescent hues and folded like a fan—are large and shining. In appearance the locust is not unlike the common grasshopper of this country. The principal differences lie in the comparative shortness of its antennæ, its somewhat stouter body, and its possessing only three foot joints, while the grasshopper can lay claim to four.

Locusts are found in all except the coldest parts of the earth. Europe, Asia, Africa, and America can each boast them as her own; but in both Europe and America they are comparatively harmless outside the tropical and sub-tropical regions of the continents. Even in these hotter states their ravages are inconsiderable compared with the terrible destruction they have wrought in Africa and some Asiatic countries, notably Arabia and its neighboring regions.

As each blessing has its bane, so every bane should bring its good along; and the good of the locust is that while it destroys all else, it can in its own person furnish that which will sustain life in both beast and man. All kinds of birds as well as quadrupeds feed upon it greedily. At first, doubtless, from necessity, when the locust had left him nothing else to eat, man, too, tried the little creature as a food, learned to relish his flavor, and has since continued to eat from choice. Some of the Arabs boil their locusts and then dry them in the sun; others cure them by soaking in oil; and again others preserve them in brine, perhaps drying them afterward. They are also roasted, or fried in butter, and eaten with honey. Besides this they are often dried and ground, and the flour-like substance resulting is made into bread.

They are even offered for sale in the markets of Arabia, Syria, and Egypt. The African bushmen cook them by making great fires. The locusts fly into the flame, their wings are burned, they fall and are roasted; then the bushman draws them forth, eats, and is happy. Some Europeans do not fancy their nut-like flavor, especially at first, while others find them palatable.

Lady Anne Blunt tells of riding through a part of Northern Arabia where a swarm of locusts had lately passed, leaving their dead and stragglers behind them. The camels ate these as a relishing morsel with their provender, and her greyhounds picked them up all day, eating a great many of them. She says they were regularly used in camp as a part of the day's ration, and thought a very fair substitute for vegetables, their flavor being somewhat like that of wheat still in the milk. After trying the many different modes of cooking, all the Europeans agreed that they preferred them simply boiled. When cooked they took the creatures daintily by the wings, pulled off their long legs, dipped them in salt, and "ate them with much relish." Lady Anne, when she first tasted them, thought them "fairly good," but soon came to consider them "a most excellent article of diet." During her visit to Arabia many of the tribes where wholly dependent upon locusts and camel's milk for their food.

Dr. Livingstone considered locusts very good eating, and they are highly prized by the natives of South Africa as affording a nourishing and whoiesome food for man, birds, and beasts. Their domestic animals—horses, cows, and sheep—fatten upon them, while they are devoured in great numbers by antelopes, hyenas, and jackals, and even elephants and lions do not disdain to eat them.—*Popular Science News.*

## MEXICAN ONYX MINES.

To the lover of geological eccentricities few localities can present greater attractions than that portion of Mexico politically known as the State of Puebla and the country immediately contiguous thereto. Within the lines of the state, or in their immediate vicinities, tower three of the greatest volcanoes in the world—Popocatapetl, Ixtaccihuatl and Orizaba, each over 17,000 ft. high, and presenting in themselves many magnificent geological studies as well as every variety of vegetation, from that of the tropics to that of the poles. One of the greatest of the many peculiar formations encountered, equaling in interest the sulphur mine contained in the bowels of Popocatapetl, are the quarries from which come the stone known as "tecali," "Mexican marble," or "Mexican onyx." In beauty no marble or similar stone ever compared with that which these quarries yielded. For centuries before the advent of the *conquistadores* of old Spain. Aztec artist and architect found in this marble their favorite material. Among them so highly was the stone prized for its beauties that it was deemed too sacred to be given to the ordinary uses of common mortality, and was devoted almost solely to the ornamentation of religious edifices or the manufacture of sacrificial vessels. So strict and arbitrary was this limitation of its use that its Indian name, "tecali," is merely a corruption of the Aztec word "Teocali" (Lord's mansion), a name given by the Indians to their temples. With Cortez and his freebooting followers the stone found as high favor, while, with that peculiarity that always distinguished them of picking out the best under all circumstances, the padres regarded it as a most meet and proper offering to the church from the devout. Altars and baptismal fonts were always made of it when it could be obtained, and among the most notable sights connected with a tour of Mexico are the magnificent collections of articles of this marble which are to be found in many churches, particularly that in the cathedrals of the cities of Mexico and Puebla, and in the churches of Leon, Queretaro and Guadalajara, several of which contain perfect slabs 3 and 4 ft. square—an extraordinary size on account of the small and irregular shape in which the stone is found.

During recent years fashion has taken up what the priests of these two religions thus marked with their approval, and the stone under the name of Mexican onyx, with its capricious markings by Dame Nature's brush, has become so well known as to make a detailed description of its different varieties unnecessary. To those who have made its acquaintance, though only through the medium of the ordinary onyx table top, clock, or the interior ornamentations of public buildings, beautiful as such are, it would be hard to convey a correct idea of the exquisite beauties of the finer grades of the marble. While the ordinary grades commonly encountered probably surpass in elegance any similar material, it is only in the light and dark green, the ivory colored, the brilliantly banded and the dark red varieties that a full realization of the stone at its best is had. Then under the touch of a skilled hand it becomes almost a gem. But while the man of civilization may work it into a thousand designs that the artistic traditions of our civilization have pronounced beautiful, and while he may even bring the sun to his assistance by cutting the translucent shades into slabs so thin that their iridescent beauty surpasses the finest glass that ever served as a window, it is only in the hands of the half-clad Indian workers found scattered through the quarries that its rare possibilities are shown. Under the touch of these the inherited skill and taste of centuries are brought into play, and from a dead, inanimate marble there seems gradually to grow something that is almost

half alive with life. Its irregular lines and strange, fantastic dashes of color change into stretches of landscape of mountains and plains, turreted castle and humbler ruin, and storm, and cloud, and almost sunshine that any eye can see.

Beautiful as the stone is, the base is simply lime. All its beauty is merely the accidental mixing of other elements, chief among which are manganese, oxide of iron and carbonic and sulphuric acids. To the iron and manganese it alone owes its remarkable combination of colors. In hardness it ranks the same as marble, but is at the same time susceptible of a much higher polish.

In the quarries it is found in the form of bowlders or detached masses, ranging in size from a few inches up to ten or twelve cubic feet. Larger sizes are occasionally found, but so rarely that the event is a notable one, while the value per cubic foot is correspondingly increased. For example, the value of a piece containing one or two cubic feet would be estimated to be ordinarily $3 per cubic foot in Mexican money, but were the piece to contain twenty-five or thirty cubic feet, the valuation would be about $15 per cubic foot. This is for ordinary stock; with green and the other finer grades it would be very difficult to form any estimate whatever. This smallness of available sizes is one of the principal defects of the stone and one with which the best skill has battled in vain. With its other defects, that of occasional flaws or holes, ranging from a tenth of an inch to two or three inches in diameter, more success has been had in remedying the negligence of nature by filling the smaller with a cement mixed with powdered portions of the stone, while in the larger a piece of the onyx is very often boldly inlaid with such skill as to defy detection on a cursory inspection. With the growing inability to supply the demand for onyx, this last method of making the most out of what remains of the stone has been pursued to a great extent, and with very good success except where the article so "improved" is subjected to sudden changes of temperature, in which case the effect of our northern climate at once becomes apparent, and the best of work under the irregular processes of expansion and contraction soon becomes unsightly. Almost as common but a more questionable method of "improving" the stone is that of sawing the inferior qualities that lack color into very thin slabs, so thin as to be almost transparent. These are then operated on by an artist, who adorns one side with a variety of colors and pencilings that make a very fair counterfeit of the real first-class article, after which the side that is painted is covered with a coating of very fine cement, which gives it the appearance of having been merely sawed and unpolished. This class of work is often done so well that when first finished it will deceive any but the sharpest of experts, but under a year or two of use the swindle becomes apparent, and soon nothing remains but a slim transparent slab of stone.

The formation constituting the quarries in which the marble or onyx is found is that of a tough reddish or dark brown clay overlying a closely cemented conglomerate. This is the usual form, but in one instance —that of the Antigua Salines, on the Ranco del Carmen—it is found in a hard, flint-like country rock which appears to be more of a bastard jasper than anything else. In this instance the onyx appears in regular vein formation, the veins varying from one to twelve inches in width.

Of the quarries themselves, all are small. The most famous—La Pedrara, in the district of Tecali, 21 miles from the city of Puebla—does not cover to exceed three acres, while the average depth of the quarrying is not over 7 ft. The value of the onyx taken from this small area, though, is hard to realize. The high reputation of the stone is recognized the world over, but it is very doubtful if one-tenth of what has been sold as "La Pedrara" during the last quarter of a century ever came from it. At present no attempt is made to work the onyx, in fact no indication of onyx in place is to be seen; the only effort made in obtaining onyx from it being by sorting over the old dumps or refuse places which have accumulated during its active existence. From these is taken every piece of onyx that will square six inches or over. The process is slow, while the yield is seemingly very small in return for the labor. The onyx obtained is of a very fine quality of green, ranging from a very light to a very dark tint, and, as a rule, showing a slight dash of red or pink. Occasionally pieces of variegated are found which are very fine, while the texture is very good.

Next in importance to La Pedrara is Antigua Salines, in the district of Tehuacan, and which has already been briefly mentioned on account of its peculiar geological formation. The quarry covers an area not exceeding two acres, and forms the face of a hill about 250 ft. high, and in working it the system has been simply a process of gouging out the onyx and the rock which incases it, until into the side of the hill there has been excavated a hole 100 ft. in width by 50 ft. in height and 60 ft. deep, looking very much as if an immense shovelful had been taken out. The onyx is variegated in colors, and is ranked next to La Pedrara. On account of the cost of taking out the marble very little has been quarried, although the property has been considered one of the finest in Mexico, in one year only, 1888, the value of the yield being nearly $400,000.

Ranking third probably in importance is La Sopresa, which covers an area of about five acres, and is located about 35 miles west of Antigua Salines, and in the same district. The onyx from this quarry is a semi-translucent white, totally devoid of colors, save where an occasional mass of green is found. The quarry has been worked for the last fifteen years only, and is at present the largest producer of onyx in Mexico. Sizes ranging as large as from two to three feet square can be obtained, which is something extraordinary in Mexican onyx deposits, and the supply "in sight" seems to be sufficient for several years. The total absence of any color to set off the pure white is to be regretted, but, as it is, the demand for the stone is sufficient to tax the quarry to its utmost to supply it.

Directly east from Sopresa about four miles is found the quarry of La Mesa, lying, as its name indicates, on a level table-topped mountain. The quarry shows quite extensive working, the product being a variegated onyx, which, however, lacks the brilliancy shown in the stone of Antigua Salines. It covers an area of nearly 30 acres, being the largest quarry in Mexico. Occasionally quite large pieces are obtained, but the average sizes prepared for shipment will not exceed 15 × 10 × 6 in., while pieces as small as 10 × 6 ×10 in. are also shipped, both to Europe and America. This, however, is the case with all the quarries, and it is the exception when pieces larger than the first mentioned are exported.

In addition to the quarries here mentioned there are many others of less importance, either by reason of their small output or from having been worked out. Among these the most interesting, on account of historical associations or past records, are those known as El Mogote, Lajas, Agua Esconda, Desamparo, Mehuantepec, Tepeyac, Tecoluco, La Paoma and La Reforma.—*Eng. and Min. Journal.*

## PROCESS OF AND APPARATUS FOR PREPARING ALUMINUM SULPHIDE.

THIS is an invention of Philip Emanuel, Aiken, S. C., who thus describes it:

My invention relates to the preparation of the sulphides of aluminum from kaolin and other ores. The bonds uniting aluminum and sulphur being weaker than those uniting aluminum and oxygen, the sulphur is more easily split off than the oxygen, and hence the advantages of the sulphide over the oxide in reduction is apparent.

I start with either the aluminum sulphate or alumina, and from sulphate or oxide of aluminum I obtain the sulphide.

My process consists, briefly, if beginning with the dry sulphate, in mixing the said sulphate with sulphur in a closed retort and heating the mixture, driving off $SO_3$ with a little free sulphur and reducing the $Al_2(SO_4)_3$ to $Al_2O_3$, probably, according to the reaction,

$$2Al_2(SO_4)_3+3S=Al_2O_3+9SO_2$$

A small percentage of sulphate remains unaltered, but this amount is so small as to be unimportant. Now, still using the same retort, or any other if preferred, I treat the solid product remaining, almost wholly $Al_2O_3$, with carbon bisulphide under pressure. (It will be apparent that I may begin with the oxide instead of the sulphate, should that be more convenient.) The reaction

$$5Al_2O_3+9CS_2=5Al_2S_3+9CO=3SO_2$$

then takes place.

The CO and $SO_2$ go off, leaving aluminum sulphide; but a considerable portion of the $Al_2O_3$ ordinarily remains unchanged and inert. By using a suitable flux, as chloride of sodium or fluorides of sodium of potassium, however, a more complete conversion of $Al_2O_3$ into $Al_2S_3$ may be obtained.

My method of accomplishing these results and of avoiding the numerous chemical and mechanical difficulties that suggest themselves will be better understood by reference to the accompanying figure, which represents a detail view, partly in section, of my apparatus.

A represents a retort of suitable material and capable of standing a high heat.

*a* is the feed pipe, having funnel, *a'*, and $a^4$ is the discharge pipe for the sulphide of aluminum, slag, etc.

$a^2$, $a^3$, etc., represent jogs or teeth suitably secured on the interior of the retort, A.

V, V, V, etc., represent ordinary stop valves.

B represents an inclosing vessel or shell, which may be made of iron lined with fire clay or with any fireproof material.

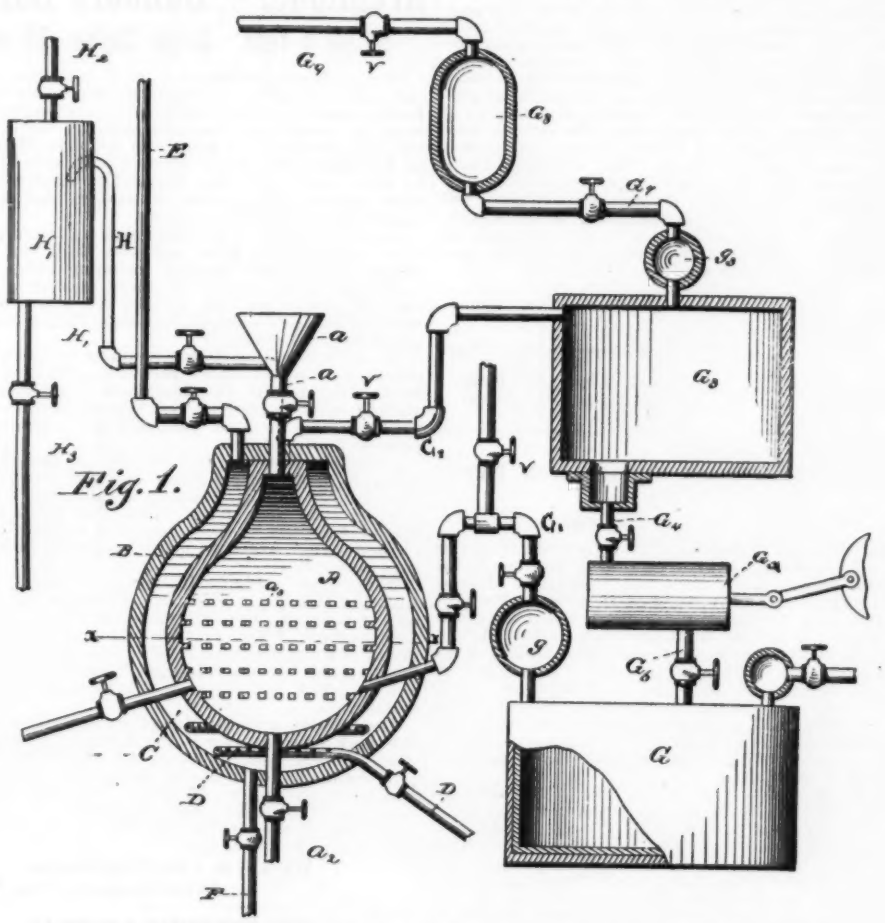



Fig. 1.

APPARATUS FOR PREPARING ALUMINUM SULPHIDE.

In the fire space, C, I have a perforated spiral pipe, D, for supplying combustible gas or gases, which may be ignited within the closed combustion chamber by means of an electric spark; but any other convenient means of heating the retort, A, may be adopted.

E represents an escape pipe for the products of combustion from the chamber, C, while F represents a drain pipe for carrying off any residual products from the said combustion.

G represents a reservoir lined with "agate ware," so called, where vapor, either carbon disulphide or sulphur, may be kept under pressure. The said reservoir is highly heated, but the source of heat is not shown.

G may have a dome or drum, *g*, from which the pipe, G', leads directly to the retort, A. This pipe enters the retort in an inclined direction in order that a rotary motion may be imparted to the fluxed materials. All the pipes and other metallic connections of the said boiler are lined with agate ware.

At the upper end of the retort, A, I have a pipe, $G^3$, for conveying the waste $SS_2$ fumes to the condensing chamber, $G^2$, whence, by means of the pipe, $G^4$, pump, $G^5$, and pipe, $G^6$, they may be forced back into the reservoir, G, and so used over and over again. The condenser, $G^2$, must be cooled in some way, and from the dome, $g^2$, a pipe, $G^7$, leads to a receiver, $G^8$, for carbonic oxide or other gaseous products, while a pipe, $G^9$, conducts these to any desired place of combustion or to any gas escape.

From the top of the retort, A, I have another pipe, H, opening into a closed water chamber, H', and from the top of this chamber I have a pipe, $H^2$, leading to a gas escape.

$H^3$ is a drain pipe for the tank, H'.

Having thus generally described my apparatus, my process is as follows:

All the valves leading to or from the retort, A, are closed, and then dried pulverized aluminum sulphate and sulphur intimately mixed are inserted into the retort through the funnel, *a'*. The valve in the pipe, H, is then opened and the fire is started in C. As before stated, the sulphur present reduces the sulphate in A to oxide, driving off $SO_3$ with other gases due to impurities. The $SO_2$ is caught in the water tank, forming $H_2SO_3$, which may be used for various purposes, while the foreign gases bubble up through the water and escape through the pipe, $H^3$. This step of the process ends when the sulphate has been nearly all converted into the oxide. It will readily be seen, since the process so far has been to obtain the oxide, that if it be more convenient to prepare the oxide elsewhere and then place it in the retort, A, for reduction, the subsequent steps of the process will not be affected.

The next step in the process is the preparation of the sulphide of aluminum. Having the oxide of aluminum in the retort, either that which I have prepared there or that introduced from other sources, I may add sulphur or carbon to promote the reaction. Any suitable fluxes—for instance, fluor-spar and chloride of sodium —may also be added for the purpose of suspending the particles of oxide therein; but, as was before stated, I may use no flux. The retort, A, has all the while been maintained at a high heat. Having now prepared the $Al_2O_3$ for reduction into $Al_2S_3$, I close all other connections and turn on gradually the $CS_2$ vapor from G, and at the same time open the return circuit, $G^2$, to the condenser, $G^2$, and start the pump, $G^4$. The $SS_2$ in G, entering A, forms a coating of $Al_2S_3$ on the adjacent particles of $Al_2O_3$. As the $CS_2$ enters at an angle and under pressure it imparts a rotary motion to the charge, and in a little while a revolving mass of fused sulphide

carrying oxide will form on the bottom of the retort and will rise higher and higher in it, the teeth, $a^3$, acting as both knives and stirrers, tending not only to bring the carbon bisulphide into contact with all the particles of oxide, but also to knock off particles of the sulphide coating and allow the $CS_2$ to attack the unaltered $Al_2O_3$ afresh. The excess of $CS_2$ is condensed in $G_2$, whence it is forced by the pump, $G^3$, back to the reservoir, G. The carbonic oxide formed is withdrawn from the apparatus after the condensation of the $CS_2$ by suitably set pop valves. (Not shown.) I may also convert $Al_2O_3$ into $Al_2S_3$ by mixing intimately $Al_2O_3$ with excess of carbon and then placing the mixture in the retort, A, where, instead of $CS_2$ vapor, I inject from G a stream of vaporized sulphur under pressure. This sulphur unites with the carbon in the retort to form $CS_2$, which in turn converts the $Al_2O_3$ into $Al_2S_3$. By either method a proportion of $Al_2O_3$ remains unchanged in the retort; but this is inert, does not perform any important function, and does not materially affect the reduction of the sulphide to the metal. Having reduced a large proportion of the $Al_2O_3$ to $Al_2S_3$, the pipe, $G^1$, is closed, and by means of the pump, $G^2$, the $CS_2$ in the retort, A, is pumped out and the molten sulphide may be either drawn off or treated for the metal in the same retort.

## ARTIFICIAL PERICLASE.

By R. OTTO and J. H. KLOOS. Ber., 1891.

PERICLASE is a crystalline variety of magnesia, in which the magnesia is partially replaced by ferrous oxide. It occurs naturally in the limestone found at Monte Somma, Vesuvius, and forms greenish, greasy crystals, which in hardness are about equal to feldspar. The authors have discovered crystals resembling periclase in a furnace employed for the manufacture of chlorine and hydrochloric acid from magnesium oxychloride, which was being repaired. Large accumulations of heavy magnesia were removed from parts of the furnace usually inaccessible, and the artificial periclase was found on the interior surface of a number of cavities existing in this magnesia. The crystals were octahedral in shape, and varied in size, the largest having edges 4 mm. in length. They exhibited a brilliant diamond-like luster, and showed signs of scalariform growth. The smaller crystals were colorless, but the larger ones had a yellowish tint. Their specific gravity was found to be 3·555—3·571, and hardness between that of feldspar and quartz. The crystals gave the following results on analysis:

| | I. | II. |
|---|---|---|
| MgO | 98·21 | 97·94 |
| $Fe_2O_3$ | 1·57 | 1·70 |

## THE SEPARATION OF RESIN FROM FATTY ACIDS.

By J. ARTHUR WILSON.

THE detection of resin and its separation from fats and oils was at one time a very difficult problem to the analyst, and in many cases was impossible. Among many processes we have those of Henderson, Barfoed, and Gladding, the latter of which has found the greatest favor. It suffers from one very serious defect, however, and that is the correction for solubility of the fatty acids and silver salts in ether. This is a very variable factor, and, of course, is dependent on the nature of the fatty matter used in the fabrication of the soap. With small quantities of resin the error thus introduced may be as much as 20 to 30 per cent., but of course, in soaps of high resin content—say 20 per cent.—the error diminishes.

Mr. R. Williams (*Analyst*, vol. xv., p. 109) obtained very good results by the process; thus, in a soap which actually contained 30·0 per cent. of resin, he obtained 30·7 per cent., but no mention is made as to whether the amount remaining in the lyes, after precipitation of the soap, was determined. As to the simple detection of resin, no doubt the best test is to boil the dry fat or fatty acids (10 drops) with 5 c. c. acetic anhydride, cool, and add 2 drops of pure sulphuric acid (1·84 specific gravity), when the reddish violet color due to resin is easily observed, 1 per cent. of which can thus be detected.

It seems that all the above processes must make way for the admirable process of Twitchell (*Analyst*, Oct., 1891), who found that whereas fatty acids are, as is well known, converted into neutral ethers on passing dry hydrochloric acid gas into their alcoholic solution, the acids constituting resin are not attacked. The process obviously may be either gravimetric or volumetric, but chemists will prefer the latter on account both of speed and accuracy.

The description of the process is as follows: 2·5 to 3 grammes of the dried fatty and resin acids are dissolved in from 25 to 30 c. c. of perfectly absolute alcohol and a current of dry hydrochloric acid gas passed in constantly. The flask containing the mixture must be kept cool by immersion in cold water. When the etherification is complete, the ethers separate and the gas is no longer absorbed. The flask is removed, corked well, and allowed to stand half an hour. It is diluted with about 100 to 125 c. c. hot water, then cooled, transferred to a separatory funnel, and agitated with 75 c. c. of ether. The watery layer is removed, and the ethereal layer washed with cold water till neutral to delicate litmus solution (twice always is sufficient). The ethereal liquid is received in a flask, the separator washed out with about 50 c. c. of neutral spirit, and the whole titrated by standard alcoholic alkali, using phenolphthalein as indicator. The alkali should be standardized by an accurate solution of half normal HCl, and should be either one-fifth or one-half normal, according to the amount of resin in the fatty acids. Taking the mean combining weight of resin as 347, then the percentage is easily calculated; it is reported both on 100 of dry fatty matter and on 100 of soap.

Twitchell's test experiments are eminently satisfactory, and I have now pleasure in confirming them by my own tests:

1. Sample of distilled fatty acids containing no resin, when treated as described, showed 0·7 per cent. resin.

2. The above distilled fatty acids, to which were added common resin to the extent of 22·5 per cent., showed, when treated as above described, 23·3 per cent. of resin, which, after deducting the 0·7 per cent. found in No. 1, gives exactly 22·5 per cent., or the amount which was added.

3. Soap made from palm oil and other fats, but no resin, gave 0·8 per cent. resin.

4. Another soap made from fatty matter of unknown origin, but no resin, gave 1·0 per cent. resin. This, it should be observed, was of a dark color, and evidently contained some altered or oxidized oily matter.

5. Soap which showed by Gladding's test 6 per cent. of resin gave 4·9 per cent. by Twitchell's process.

The above results are all that may be desired, and I have now to show how the process may be still further shortened without any sacrifice of accuracy. This can be done by leaving out the washing and dissolving in alcohol direct. A few drops of methyl orange are then added and alkali till neutral to this indicator; phenolphthalein is then added, and the titration completed as before. The alkali required in the first case is for the neutralization of the free hydrochloric acid, and is of course neglected. That required to neutralize to phenolphthalein is of course due to the resin, and is calculated as such.

Tottington Mills, October 6, 1891.—*Chem. News.*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